



A Contributing Role of Parental Investments in Early Learning to Head Start Impacts on Children's Language and Literacy: Examining How Mechanisms of Program Impact Differ for Spanish-Speaking Dual Language Learners (DLL) and Non-DLL

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**A Contributing Role of Parental Investments in Early Learning to Head Start
Impacts on Children's Language and Literacy:
Examining How Mechanisms of Program Impact Differ
for Spanish-Speaking Dual Language Learners (DLL) and Non-DLL**

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A Thesis Presented to the Faculty
of the Graduate School of Education of Harvard University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

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Dedication

*If I speak in the tongues of men and of angels,
but have not love, I am a noisy gong or a clanging cymbal.
And if I have prophetic powers, and understand all mysteries and all knowledge,
and if I have all faith, so as to remove mountains,
but have not love, I am nothing.
If I give away all I have, and if I deliver up my body to be burned,
but have not love, I gain nothing.
—1 Corinthians 13:1-3*

Love brought me forth and carried me through my doctoral journey at the Harvard Graduate School of Education (HGSE).

None of this work would have been possible without the love of many to whom I would like to dedicate this dissertation.

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Abstract

The national Head Start Impact Study (HSIS) estimated the average impact of an offer of Head Start treatment (“Intent-to-Treat,” or ITT). The HSIS was an experimental study of a nationally-representative sample of 4,440 preschoolers, across 378 centers, in 22 states, with participating children being randomized to an offer of one year’s attendance in the Head-Start Program versus assignment to a control condition, under which no offer was made but families were free to continue with whatever child-care arrangements they favored personally. The impact study found that an offer of one year’s attendance in the Head Start program had small impacts on children’s language and literacy. Additionally, and most interestingly, the HSIS reported that an offer of program attendance produced larger impacts among Latino Dual Language Learners (DLL,) but the question remains why these particular children benefitted from the program more than did their English-speaking peers.

However, the evaluation did not investigate whether changes in parenting practices mediated these program impacts on children’s learning. In this thesis, I argue that a study of the key mechanisms through which the program impacted child outcomes remains central to understanding *why* Head Start improved children’s language and literacy. Thus, in my thesis, I have unpacked the mechanisms that mediated these detected effects—through parental practices—using two complementary estimation strategies: [1] multilevel structural-equation modeling and [2] average causal mediation effect estimation, by reanalyzing the original study data. A central aim of my research was to contribute to the body of early childhood research and inform policy directions and program development by: (a) investigating whether ITT effects on early child

language outcomes were mediated through parent-child language-and-literacy activities, and (b) conducting multi-group comparisons to test whether the impact of these mediational pathways differed by the child's DLL status.

I found that, on average, assignment increased children's vocabulary and reading scores (effect sizes $=+.13$; e.s. $=+.17$), respectively. The randomized offer of Head Start also increased the frequency of parent-child language-and-literacy activities (e.s. $=+.25$). This impact was larger for Latino parents of Spanish-speaking DLL. Additionally, I found statistically significant indirect effects: 14% of the total impact on vocabulary scores and 18% of the total impact on reading scores were mediated through parent-child language-and-literacy activities. In addition, the causal mediation effects of program impact on vocabulary and reading differed by DLL status: 12% of the impact on vocabulary was mediated through parent-child language-and-literacy activities for DLL children, compared with 18% for non-DLL. And for reading, 37% of the impact was mediated through parent-child language-and-literacy activities for DLL children vs. 4% for non-DLL children. I conclude with important directions for how early childhood programs can improve parental investment in early learning for diverse groups of children, and explanations for why mediated effects differed by language status.

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The number of young children living in low-income families has increased dramatically since 2007 (Fox, et al., 2014), even though antipoverty policies have played a growing role in reducing child poverty. Indeed, the prevalence of poverty is highest among America's youngest children during their most formative years: nearly half of children between birth to age 6 (close to 12 million) live in low-income families with incomes less than double the federal poverty threshold (U.S. Census Bureau, 2013). Additionally, the poverty rates for Black (38.3 percent) and Hispanic (30.4 percent) children are much higher than they are for white children (10.7 percent). In addition, recent growth in family-income inequality has direct consequences for all these children, jeopardizing their ultimate educational opportunities and life chances (Duncan & Murnane, 2011; 2014).

The *War on Poverty*, declared five decades ago, included Head Start, a pioneering project in early education at scale (Zigler & Styfco, 1993). Head Start was designed to combat disadvantages in early learning and development faced by children in poverty, and to reduce early income-based achievement gaps between *haves* and *have-nots*. Two primary mechanisms make up Head Start's theory of change—first, direct educational impacts on children through its classroom-based component, and second, impacts through improving parental factors, including parenting practices that promote children's learning (Head Start Advisory Committee, 2012). Among these latter targets are parental behaviors hypothesized to support children's early language and literacy. Indeed, evidence suggests that children in low-income families acquire stronger early academic

skills when parents talk with them and engage them in early learning activities (Hart & Risley, 1995; Rodriguez & Tamis-LeMonda, 2011; Rowe, 2012).

In this dissertation, I tested this mediational hypothesis concerning Head Start's effects—specifically, that improved parent-child language-and-literacy activities contribute to Head Start's short-term effects on children's language and literacy. I built on prior work in several ways. First, I designed and included a psychometrically-sound latent construct of parent-child activities, developed from responses to indicators in the HSIS, as a mediator in the indirect path between the principal question predictor (an offer of Head-Start treatment) and the child's educational outcomes. Second, I employed two approaches—[1] multilevel structural-equation modeling (MSEM) and [2] average causal mediation effect estimation (ACME)—to estimate the magnitude of mediated effects on children's language and literacy through parental practices. Finally, I conducted multigroup analyses to test whether the child's DLL status moderates the mediational effects on their vocabulary and reading scores.

In the following *Background and Context* section, I synthesize the theoretical and empirical literature on the hypothesized relations among family socioeconomic characteristics, parent-child interaction, and children's early language and literacy development. I also provide context regarding Head Start as a preschool intervention. In the *Research Design* section, I describe my dataset, sample and measures, and the two estimation strategies that I used to address my research questions. Then, I present results from both sets of analyses and compare them. Finally, I discuss the implications of my research findings for future research, policy and practice.

Background and Context

Income Disparities in Early Language and Literacy Development

Socioeconomic disparities in cognitive and language skills develop in the first years of life, setting children on academic trajectories with far-reaching consequences (Magnuson & Waldfogel, 2005; Reardon, 2011). On average, by age 3, a child of professional parents has been exposed to 30 million more words than a child of working-class parents (Hart & Risley, 1995). These authors also found striking differences in the quality of the language to which children were exposed at home, by socio-economic status (SES): on average, working-class families used shorter utterances and words of less complexity. More recently, Fernald and colleagues (2013) confirmed that a language-skill gap, associated with family SES, was evident by 18 months: By age 2, a 6-month gap existed between toddlers from rich and poor families in language-processing skills and vocabulary knowledge. Furthermore, it has been well-established that low-income children enter kindergarten with lower cognitive and language skills than do their advantaged peers. Consistently, children with higher levels of early vocabulary and reading skills demonstrate higher academic achievement in elementary and middle school (National Early Literacy Panel, 2008). The result of these patterns is that by age 8, most low-income children are no longer on track in cognitive knowledge and skills. Only 19% of third graders from lower-income families demonstrated age-appropriate cognitive skills, compared to 50% of children in higher-income families (Casey Foundation, 2013).

One of the key mechanisms hypothesized to drive this income-based achievement gap is the increasing parental investment in children's cognitive development in recent decades among higher-income families (Reardon, 2011; Schaub, 2010), and the steady

increase in highly-educated mothers' time spent with their children in interactive and developmental childcare activities, rather than in routine and physical childcare activities (Phillips, 2011). In fact, SES has become a particularly important predictor of parenting behaviors, in general (Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997; Lareau, 2011). Parents with more socioeconomic capital tend to provide their children with experiences that are more cognitively stimulating than do parents with less capital, including: more enriching and organized activities, more conversations, using more complex words, reading more books, and teaching more school-related concepts. These parenting behaviors all contribute to children's cognitive and language development (Bradley, Corwyn, McAdoo, & Garcia Coll, 2001). In contrast, in low-income families with children aged 8 and younger, less than two-thirds of household heads possess a high-school diploma (Casey Foundation, 2013). Finally, economic hardship and psychological distress can further diminish low-income parents' capacity to provide cognitive stimulation (McLeod & Shanahan, 1993; McLoyd, 1990, 1998).

Role of Parent-Child Interaction in Early Language-and-Literacy Development

Language and literacy development begins early in a child's life, and depends on environmental influences, and in particular, the frequency and quality of parent-child interaction (Snow, Burns, & Griffin, 1998; Tamis-LeMonda, Kuchirko, & Song, 2014; Thompson, 2000). Parent-child interaction characterized by contingent responsiveness facilitates growth in children's cognitive and language competencies (Tamis-LeMonda, Bornstein, & Baumwell, 2001; Rowe, 2012). More broadly, cognitive stimulation is a construct used widely to encompass parents' support of their children's learning and

development, and subsumes educational activities and cultural experiences such as trips to museums, libraries, and recreation.

One key subset of cognitive stimulation on which I focus in this research is parent-child language-and-literacy activities, because I hypothesize that their association with child language outcomes is specific and a particularly powerful driver of growth in this developmental domain (Bradley, Corwyn, McAdoo & Garcia Coll, 2001; Snow & Dickinson, 1990). From an economic perspective, parent-child language-and-literacy activities represent one aspect of how parents invest in their children's early learning, for the purpose of building the children's human capital. From cognitive and psycholinguistic perspectives, early literacy draws upon multiple interrelated domains including oral language, phonological awareness, knowledge of the graphic features of print (e.g., letter shapes), understanding of how sounds map onto print, and a sense of the varied uses of print (Snow, Burns & Griffin, 1998; Whitehurst & Lonigan, 1998). In this thesis, where I investigate deliberately the mediated effect of an offer of the Head Start treatment on child outcomes through parental practices, I focus on a multifaceted construct of parent-child activities—including shared reading, oral storytelling, letter and word learning, early writing, spelling, and rhyming—that each support various aspects of children's language and literacy development and that I hypothesize constitute a single latent construct.

- *Shared Reading*

Reading books to children (or booksharing) is a common parent-child literacy routine evident during the preschool years. Booksharing supports children's emergent literacy skills by providing [1] semantically diverse models of language, [2] narrative

based on words rather than just pictures, [3] multiple forms of linking meaning to words (e.g., not only declarative, but conceptual), and [4] larger and more sophisticated vocabulary related not only to objects and people, but also to internal states, emotions, and motivation (Arnold, Lonigan, Whitehurst & Epstein, 1994; Bradley et al., 2001; Wagner & Hoff, 2012). A substantial body of evidence supports the hypothesis that parent-child booksharing influences children's skills foundational to language and literacy development, including narrative skills, vocabulary growth, knowledge about the world, learning of print concepts, and story comprehension (Farver, Xu, Lonigan, & Eppe, 2013; Payne, Whitehurst, & Angell, 1994; Sénéchal, 1997). These skills that children acquire through booksharing, in turn, can promote the child's school readiness, academic achievement, and socio-emotional skills in subsequent years (Bus, van Ijzendoorn, & Pellegrini, 1995; Curenton, 2011; Dickinson & McCabe, 2001; Rodriguez & Tamis-LeMonda, 2011).

- *Oral Storytelling*

Oral storytelling—a literacy routine in which people share life experiences, memories, folk tales, and historical events without the support of print materials—is used to transmit cultural values and family history (Isabell, Sobol, Lindauer, & Lowrance, 2004; Tamis-LeMonda & Song, 2012) as well as provide explanations about how and why people behave and things happen the way they do (Blum-Kulka & Snow, 2002). Oral storytelling is an intergenerational, language-rich activity that can provide explicit and implicit socialization for sociocultural norms, interpretive framings, and expectations that relate to language and context, which in turn, promote the development of children's discourse skills (Ochs, 1990). Retelling or making up stories can further foster children's

phonemic skills, print concept knowledge, and positive attitudes toward literacy (Raikes et al., 2006; Wagner, Torgessen, & Rashotte, 1994). Furthermore, oral storytelling is valued traditionally and practiced widely, particularly among African-American and Latino communities, as an alternative way of socializing language, strengthening interpersonal connections, and cultivating children's ethnic identities (Heath, 1982; Riojas-Cortez, Flore, Smith & Clark, 2003).

Children can acquire language and literacy skills through conversations with adults in multiple contexts. Adult-child conversations and child-directed speech during the preschool years support language development strongly (Landry et al., 2006; Snow & Blum-Kulka, 2002; Zimmerman et al., 2009). Children whose parents provide rich language input to verbal and other communicative bids score higher on IQ and vocabulary assessments, on average, perhaps because they scaffold child learning more effectively (Bradley, Corwyn, McAdoo & Garcia Coll, 2001; Tamis-LeMonda, Bornstein, & Baumwell, 2001). Further, low-income children who experience more child-directed speech and higher-quality language interaction with caregivers appear more efficient at interpreting speech and display more rapid growth in their vocabulary as well as conceptual knowledge (Bloom 1998; Fernald & Weisleder, 2013; Hoff, 2003; Hurtado, Marchman, & Fernald, 2008; Rowe, 2008; Weisleder & Fernald, 2013;).

- *Letter and Word Learning*

Research shows that how parents talk about words and letters with their children influences the latter's literacy development in multiple ways. Learning to sing, or recite the alphabet in order, is not as important for teaching reading and writing skills as understanding the order of letters in particular words. Low-income parents, in general,

tend to focus more on the conventional alphabetic order, and talk more about absent letters (i.e., letters uttered without visible references in the context) with their children (Robins, Treiman, Rosales, & Otake, 2012). When parents talk about absent letters, many of these utterances involve reciting the alphabet sequence, spelling words or talking about letters associated with words. Additionally, children's vocabulary and early literacy were strongly reflective of the varied use of vocabulary during meal times in one study (Tabors, Beals, & Weizman, 2001).

- *Early Writing and Spelling*

The characteristics of parent-child interaction that support language acquisition (e.g., semantic contingency, scaffolding, the use of routines) also facilitate early reading and writing development (Snow, 1983). Preschool children's emergent writing is comprised of several skills, including name-writing, letter-writing, and spelling (Puranik, Lonigan & Kim, 2011). Learning to spell is associated strongly and positively with reading yet requires unique additional processes of retrieving and representing word knowledge (Ehri, 2000). Early spelling in alphabetic languages represents the cognitive process of deciphering the linguistic structure of spoken words to create graphic representations of them (Treiman & Courassa, 2000). Children rely on their phonological awareness and their knowledge about the sound-spelling correspondences, in addition to rote visual memorization in learning how to spell (Templeton & Morris, 2000). Based on a comprehensive review, the National Early Literacy Panel (2008) concluded that four emergent literacy skills play an important role in the development of spelling skills, including alphabet knowledge, phonological awareness, print knowledge, and name-writing.

Children with parents who teach conventional literacy skills (decoding, spelling, writing) more frequently show stronger oral language, print knowledge, and letter-sound correspondence skills (Senechal, LeFevre, Thomas, & Daley, 1998; Burgess, Hecht, & Lonigan, 2002). Helping children practice writing the alphabet or spelling names also promotes emergent language and literacy. Early spelling development in English and Spanish requires phonological awareness and letter knowledge. Practicing invented spelling promotes young children's phonological awareness—ability to focus on graphemes (e.g., segments of visual input) and link them to phonemes (e.g., segments of spoken input) (Watt, 2001). Interactive writing is the most meaningful writing context for preschool children. Writing symbols, letters, or drawing pictures provides the opportunity for children to talk about their experiences or certain topics. When parents provide cognitive support in an early numeracy-writing task, they can use multiple teaching strategies such as counting and comparing magnitudes, dictating and sounding out letters, and introducing and connecting novel and familiar words to scaffold the child's cognitive and language development (Leyva et al., under review).

- *Rhyming*

Routinized activities in which children practice rhyming words can further contribute to literacy acquisition. Dr. Seuss books, for example, use rhyme and rhythm as children match rote-learned sequences to visual displays of words. Parents who incorporate nursery rhymes, songs, chants, and poems in a literacy routine teach children to sound out words and learn words that rhyme together (e.g., cat, mat, bat). Learning to read well-memorized rhymes in a book is an example of a highly contextualized literacy skill, similar to reading the words on cereal boxes, or reading one's own name (Snow,

1983). Rhyming is one way in which preschool-age children can learn to blend and segment sounds before learning the relationship between letters and sounds in print. Rhyming teaches children phonological awareness—the ability to manipulate sounds in words independent of word meaning. Phonological awareness must be taught systematically, sequentially, and explicitly, and benefits from a focus on identifying, detecting, deleting, segmenting, and blending segments of spoken words. These activities further help build children’s oral language and alphabet knowledge: Preschool children who detected rhyme and word-onset better, on average, scored higher in reading and spelling achievement in later years (Bryant, McLean, Bradley & Crossland, 1990).

Parent-Child Literacy Activities and Early Childhood Interventions

Enhancing parent-child interactions through early childhood intervention is theorized to be a mechanism for improving educational and developmental outcomes for children from economically-disadvantaged families. More specifically, training parents with skills and strategies to foster children’s language and literacy has been an integral component of early childhood programs and a promising path to addressing systematic differences that exist in children’s early home-learning experiences. For instance, randomized evaluations of *Early Head Start*, serving low-income pregnant women and toddlers up to age 3, have found very small but favorable impacts on maternal supportiveness and cognitive stimulation (DHHS, 2002). However, most studies that have evaluated interventions to enhance parent-child language-and-literacy activities have examined family-literacy programs (e.g., Avellar, Paulsell, Sama-Miller & Del Grosso, 2013; Leffel & Suskind, 2013; Lowell, et al., 2011; Nievar, et al., 2011; Ricciuti, et al., 2004). Typically, these programs mainly target children aged 0 to 3 and provide

services to parents, either in groups or through home visits, to encourage their engagement in language-building and cognitively-stimulating activities with children.

Several early childhood education (ECE) models for preschool children across the past several decades have targeted parent-child interaction as an integral program component. Through home visits, these programs offered feedback for parents, enhanced the way parents interacted with their child, and provided real-life applications to help parents engage their children verbally. For example, both the *Perry Preschool* and the *Chicago Child Parent Centers* (CPC's) provided a half-day program for 3- and 4-year olds while offering home visits to encourage parents to be more involved in their child's early learning. Both were evaluated using randomized controlled trials and their samples of children were followed into adulthood. In particular, High/Scope Perry Preschool offered weekly home visits from teachers to inform parents about what was being taught in the classroom and to encourage some of the parent-child learning activities. The CPC's, on the other hand, focused more on parent involvement rather than specific language and literacy activities. A recent evaluation of READY4K!—an early literacy text messaging program for parents of preschool children found that parents' engagement in home literacy activities with their children was 0.22 to 0.34 standard deviations higher in the respective treatment groups (York & Loeb, 2014). More specifically, the READY4K! treatment increased the frequency with which parents told stories, pointed out two words that begin with the same sound, pointed out rhyming words, recited nursery rhymes, looked at pictures in a book, showed the different parts of a book, and played games or worked on a puzzle with their children. Increases in these parent-child literacy activities translated into student gains in some areas of early literacy, that ranged

from 0.21 to 0.34 standard deviations higher on the PALS lower-case alphabet knowledge and letter sounds subtests.

As efforts to expand preschool education have intensified over the past decade, there also has been growing interest in enhancing the quality of these programs for dual language learner (DLL) populations. *Avance*, for example, is a two-generation parent-child education program that has shown promising evidence of effect on Latino families through partnerships with community-based organizations serving low-income families. The Avance program has collaborated with the Head Start program in Texas and the collaboration serves predominantly Spanish-speaking populations to provide both center-based ECE and family support for parenting practices, including learning activities that promote children's language and literacy development. Though less evaluated in comparison to flagship preschool programs, participating parents improved in their ability to provide stimulating and nurturing home environment and their children scored higher on reading achievement assessments.

Abriendo Puertas (or Opening Doors) is one of the largest peer-to-peer parent-training programs that focuses on building the capacity of Latino families with children aged birth through five. Currently, Abriendo Puertas partners with the National Head Start Association and provides a curriculum comprised of 10 interactive lessons. The first random-assignment evaluation of this culturally-relevant parenting program found that parents in the treatment group enhanced their parenting practices, especially related to educational support in the home (Caal, Moore, & Rojas, 2015). Relative to the parents in the waitlist control group, Latino parents who participated in the program improved in several aspects: [1] parent-child literacy activities at home (i.e., such as reviewing the

letters of the alphabet and reading to their child more frequently), [2] parents' approaches to shared reading (i.e., pausing to talk about the story with the child), [3] library use (i.e., frequent visits and checking out reading materials to take home), and [4] knowledge about high-quality preschool settings.

Whether center-based early-childhood education programs have positive impacts on parents' effort investment in their children, such as parent-child language-and-literacy activities, has been studied less (Gelber & Isen, 2012). Yoshikawa and colleagues (2013) suggest that intensifying and specifying program components that build parenting practices increases the impact of preschool for children. Additionally, a recent meta-analysis showed that a parenting-focused component of early childhood interventions could produce added gains in children's cognitive skills (Grindal et al., 2013). The type of parenting support that produced additive benefits, beyond that of preschool, involved modeling of positive parent-child interactions and opportunities to practice newly learned parenting skills, with feedback. Didactic workshops or simply supplying information to parents produced no additional benefits. However, recent advances in parenting interventions that target behavior-management approaches or contingent responsiveness are not yet widely integrated into preschool systems (Landry, Smith, Swank & Guttentag, 2008). The question remains as to whether boosting parent investment in early learning could be one mechanism through which long-term impacts of early childhood programs could be sustained (Gelber & Isen, 2012).

Most research on early childhood education has focused greater attention on evaluating programs than on identifying particular mechanisms in these programs that produce improvements in children's learning (Duncan & Magnuson, 2013). Evaluations

like the *Ready4K* evaluation (York & Loeb, 2014), which assessed parent-child literacy activities as a mediator of program impacts on child language and literacy, are rare. The mechanisms through which comprehensive early childhood interventions like Head Start have improved children's school readiness are thus not well understood. One common criticism of experimental evaluation in the social sciences is that randomized trials can tell us whether a treatment affected an outcome causally but often cannot tell us how and why such an effect occurred in a causal manner. Identifying the "active ingredients" should be a priority in future research on understanding the impact on young children of prekindergarten programs (Weiland & Yoshikawa, 2013). In my thesis, for instance, I have investigated *why* Head Start worked, by testing whether an offer of enrollment in Head Start succeeded in improving parent-child language interaction, and whether this experimentally-induced improvement in parent-child interaction then explains the positive knock-on effects of Head Start on children's vocabulary and reading skills.

The Head Start Impact Study

Head Start is the largest and longest-standing publicly-funded preschool program. It serves more than 900,000 low-income children and their families, with an annual budget of roughly \$10.1 billion. From its inception in 1965, Head Start's two-generation approach has emphasized engaging parents in their children's early learning experiences and development, as part of its theory of change (Zigler & Valentine, 1979). Undergirding this approach is a belief that children's optimal development depends on nurturing and responsive relationships with adults. Additionally, children assigned to Head Start receive comprehensive services including classroom-based education, medical, dental, and mental-health care, nutrition services, and home visits. Head Start is

mandated to form “parent committees” as part of a formal structure of shared governance: parents of currently-enrolled children participate in program operations, policy-making, and curriculum development. Head Start further empowers parents by giving preference to them for employment vacancies at the center and by referring parents to community resources.

More specifically for the purposes of this study, Head Start “must provide parent involvement and education activities” as well as “opportunities for children and families to participate in family literacy services” (Appendix A: Head Start Program Performance Standards). Moreover, the Performance Standards state that Head Start aims to “increase family access to materials, services, and activities essential to family literacy development”. Head Start centers “must provide opportunities for parents to enhance their parenting skills, knowledge, and understanding of the educational and developmental needs and activities of their children”. Head Start parents might acquire specific teaching strategies to promote early learning at home as they are encouraged to “participate with children in group activities” and “observe children and share their assessments with staff to help plan learning experiences of the child.” These standards present clear evidence that language and literacy activities are part of the Head Start program’s theory of change for how the program might encourage broader program goals, like parent engagement in general. While the performance standards do not articulate specific teaching strategies nor parenting behaviors, some Head Start programs may interpret these performance standards as a strong impetus for promoting parent-child language-and-literacy activities at home.

The HSIS final report—summarizing the impacts detected in the first randomized-control trial of Head Start in the program’s history (DHHS, 2010)—showed that the offer of Head Start had small positive impacts on children’s early language and literacy (specifically, vocabulary and letter-word identification). However, the impact study did not examine the causal impact of the program offer on any multi-item measure of parental investment in early learning in the data set that might have mediated program impact. Instead, the HSIS investigators reported the estimated impact of the intent-to-treat (ITT) on responses to a single parental item involving children’s educational activities (whether the parent read with the child, or spanked the child). The final report did not have as its objective to investigate the mechanisms through which Head Start produced impacts. The investigators therefore did not examine whether differences in parenting practices were implicated in mediating program impacts on children’s learning. We do not know, for example, whether an offer of Head Start programs itself impacts the parent-child literacy interaction, and whether this, in its turn, augments the positive effects of the offer on children’s early language and literacy. In the current study, I aim specifically to investigate a comprehensive set of parent language-and literacy activities that I hypothesize mediate early language development.

One prior study is most directly relevant to mine. Using an instrumental-variables (IV) approach, Gelber and Isen (2012) examined the effect of Head Start enrollment on parents’ involvement with their children. Under the “no third path” assumption of the IV approach, they found that accessing Head Start caused a substantial increase in parents’ investment in children’s learning. The largest impacts were found for types of parental investment hypothesized most likely to impact child human capital (i.e., reading

activities). In response to Head Start access, parents read to their children more often, and for longer time—by 19 minutes per week, on average. Similar to the HSIS investigators (2010), however, Gelber and Isen did not investigate the question of mediation that I have examined here. Additionally, they did not conduct psychometric work to investigate whether responses to the parenting items that constituted the parent-child learning-activities scale were unidimensional, but rather conducted multiple analyses of responses to single items. In experimental evaluations of multifaceted interventions like Head Start, researchers and policymakers are interested not only in *whether* a given intervention had an effect but also *why* (Bloom, 2005; Page, 2012; Reardon, Unlu, Zhu, & Bloom, forthcoming). Currently, we do not yet understand the central mechanisms through which Head Start improved children's early language and literacy.

Dual Language Learners (DLL) in Preschool Evaluation Studies

U.S. young children are for the first time in our country's history "Majority Minority" and will be in coming decades (Hernandez & Napierala, 2012). Evidence from the HSIS suggests that the offer of Head Start had a stronger positive effect on several developmental outcomes among Latino DLLs than among other racial or ethnic groups (DHHS, 2010), which aligns with other preschool evaluations. In prekindergarten (PreK) studies in both Boston and Tulsa, researchers also found larger positive effects on cognitive and language outcomes for Latino children, when compared to White children (Gormley, Gayer, Phillips, & Dawson, 2005; Weiland & Yoshikawa, 2013).

More recent studies of the heterogeneity of treatment effects of Head Start have revealed a consistent story, regarding DLL children. First, Bloom and Weiland (2015) quantified variation in effects of Head Start, during the first follow-up year, and found a

striking pattern of subgroup effects, indicating substantial gains for Spanish-speaking DLLs with low pretest scores. Another study reported that while gains from an offer of Head Start “faded out” for non-DLL upon entering elementary school, they did not fade out for Spanish-speaking DLL children, who showed moderate effects on vocabulary (+0.47 of a standard deviation) that persisted through grade 1 (Bitler, Hoynes, & Domina, 2014). Further, Cooper and Lanza (2014) used a latent-class moderation approach to examine differential treatment effects in the HSIS, and found a consistent positive effect on cognitive outcomes for the children in the latent subgroup defined as “married, DLL, with low parental education,” with benefits on reading skills lasting into grade 1. But, we know almost nothing about *how* and *why* Latino DLL may benefit disproportionately in this way. Given that one in three children enrolled in Head Start and Early Head Start is a Spanish-speaking DLL, and that both programs emphasize cultural responsiveness and linguistic sensitivity, in the current study I investigate potential heterogeneity in hypothesized mediational effects, by DLL status.

Research Questions

Given the focus of my research questions on mechanisms of impact, I frame them in the hypothesized path diagram of Figure 1. In the figure, using standard notation, I articulate the hypothesized directions of influence to which my mediational hypotheses, outlined above, have led. I display a fully-mediated model with hypothesized relationships among treatment offer, a mediator representing parent-child language-and-literacy activities, and vocabulary and emergent reading outcomes, at the end of first follow-up year. First, latent-regression parameters, g_1 , g_2 , and g_3 , represent hypothesized *direct* paths (solid arrows) linking treatment offer (an exogenous single-indicator

construct, on the left), to the mediator (center) and each of the child literacy outcomes, respectively (single-indicator constructs, on the right). Next, in the upper center, the mediator is represented by the unit-weighted composite scores on the frequency of parent-child activities. Regression parameters, b_1 , and b_2 , represent the second leg of hypothesized *indirect* paths (dashed arrows) linking treatment offer to the children's vocabulary and reading-skill outcomes through the mediator, respectively. Lastly, in the box at the bottom, I indicate that I controlled for exogenous elements of context by including a selected set of covariates, to be described later. I did not include the specific paths that link these covariates to outcomes, in the figure, in the interests of clarity.

[INSERT FIGURE 1 HERE]

My first research question concerns *only* the hypothesized *direct* effects of the randomized offer of Head Start on both parent-child activities and children's vocabulary and emergent reading-skills. In the figure, solid lines represent these direct ITT effects on the mediator and child outcomes. Thus, I frame my first research question in terms of a *reduced* (and non-mediated) path model, in which the (dashed) pathways from mediator to child outcomes have been removed. Thus, my first research question is:

RQ1: What is the causal impact of an offer of Head Start on parent-child language-and-literacy activities and children's vocabulary and reading skills?

Then, I hypothesize that parent-child language-and-literacy activities function as a proximal mediating process, and provide an *indirect* path (dashed arrows) linking the treatment offer and children's literacy outcomes, through the mediator. Thus, my second research question is:

RQ2: Are the impacts of Head Start on early language and literacy skills mediated through its impact on parent-child language-and-literacy activities?

Finally, I hypothesize that the pattern of mediated effects detected in the previous question will differ for populations of DLL and non-DLL children. Thus, in my analyses, I use a multi-group approach to re-address the question above (*RQ2*), while permitting the parameters representing the hypothesized direct and indirect paths to differ for the DLL and non-DLL populations. My third research question is therefore:

RQ3: Are these impacts and associations different for Dual Language Learners (DLL) compared to their non-DLL peers?

Research Design

Conceptually, a mediator is a construct in a causal pathway that leads from an independent variable (i.e., an offer of treatment assignment) to an outcome *indirectly*. Quantitative methods for modeling mediational processes remain an area of exploration in the methodological literature (Frangakis & Rubin, 2002; Gallop, et al., 2009; Jo, 2008; Murnane & Willett, 2010; Page, 2012; Sobel, 2008). Assessing causal mediation requires confirming: (1) a direct causal link between treatment and outcome; (2) a direct causal link between treatment and hypothesized mediator; (3) a direct causal association between mediator and outcome (Baron & Kenny, 1986; Murnane & Willett, 2010; Shrout & Bolger, 2002). Unfortunately, a randomized experiment like the HSIS does not also randomize participants to the levels of the mediator, undermining my ability to test the causal link between mediator and outcomes. Therefore, I am limited in my ability to make causal inferences about the indirect effects.

Some have suggested an instrumental-variables estimation (IVE) approach to resolving this causal dilemma (Gennetian, Morris, Bos, & Bloom, 2005). In this approach, exogenous variation in the hypothesized mediator is teased out using the experimental assignment and then used to estimate the causal association between the mediator and outcome (Angrist, Imbens & Rubin, 1996; Gennetian, Magnuson & Morris, 2008; Murnane & Willett, 2010). Unfortunately, to provide unbiased estimates, IVE must satisfy an *exclusion restriction*. This means that the method requires the hypothesized mediator provide the *only* plausible causal pathway between randomly assigned treatment and outcome. When there remains the possibility of a direct effect between treatment and outcome, or in complex social-program evaluations with multiple unobserved potential mediating pathways between treatment and outcome, in addition to the central mediating pathway, this assumption fails and the estimation of the mediated causal effect is biased. This is the case with the Head Start evaluation. For instance, in addition to parent-child language-and-literacy activities, the Head Start program's theory of change itself suggests several other potential mediators including: the quality of classroom instruction, social services provided to families, and community and family engagement (Head Start Performance Standards, 2009). Therefore, I present two analytic approaches to investigating the role of parental investment in early learning as one of the key mechanisms of program impact on children's language and literacy.

Dataset

In 1998, as a part of the national reauthorization of Head Start, Congress mandated that an experimental estimate of the program's impact on parents and children be obtained. The ensuing *Head Start Impact Study* (HSIS) was a two-cohort, multi-site,

longitudinal, experimental study of a nationally-representative sample of 4,440 three- and four-year-old children, across 378 Head Start centers and 568 non-Head Start programs, in 22 states. Taking advantage of the fact that most Head Start centers have long waiting lists of parents who wish to enroll their child in the program, the HSIS used a random lottery to offer the opportunity to enroll. The 2,644 children randomized to treatment were offered a slot in a Head Start program, while the 1,796 children randomized to control could seek child care services in their community (center-based, home-based, or another Head Start).

Sample

My analytic sample contains 3,578 children who were approximately three-years old (55%) and four-years old (45%) at baseline, in 189 centers. In my analyses, I first included all children for whom data on the vocabulary outcomes and the mediating parent-child activities were available, during the first follow-up year. Second, I included all children for whom there was a complete randomized block at the center level (defined as at least one child with data for vocabulary that was assigned to treatment and at least one child with data for vocabulary that was assigned to control status). Ultimately, my analytic sample contained 81% of children and 98% of the centers in the original sampling frame. The Centers were the intact units within which random assignment to treatment status occurred.

Based on similar studies conducted using this same methodology in smaller samples, I concluded that my final sample size provided high power to detect small effect sizes at usual levels of Type I error (e.g. Reynolds, Ou & Topitzes, 2004; Tein, Sandler, MacKinnon & Wolchik, 2004). Note that these prior studies investigated the mediation of

their respective program effects, fitting more complex multivariate models than mine, with smaller samples (1,200 and 157, respectively) than the smallest subgroup present in my analysis (the 1,206 children in the DLL group) and detected statistically significant, small program effects and indirect associations successfully.

In Table 1, I display descriptive statistics for outcomes, mediator, and selected sociodemographic characteristics overall, and separately by treatment assignment and by language status. Participating children were diverse—50% were male, 30% were Black, 38% were Latino, 19% had a recent immigrant mother, 69% had mothers with a high school diploma or less, 49% lived with both biological parents, and 27% were DLL. The mean age for children was 4.03 years, and mothers were 29.2 years-old, on average, at baseline. There were no statistically significant differences between treatment and control groups on 13 baseline characteristics (pretest scores, child age, sex, race, language, lives with a biological dad, mother's education, mother's age, whether mother was a recent immigrant). However, I observed some differences by language status. As previous studies would support, a greater proportion of DLL children lived with mothers with lower levels of education (64% of DLL mothers had less than high-school education, compared to 29% for Non-DLL mothers), had mothers who were married (66% versus 37%), and lived with a biological dad (76% versus 40%). Parents of DLL children also scored almost an entire standard deviation lower on parent-child language-and-literacy activities than did parents of Non-DLL at baseline (0.57 versus 0.45). Finally, DLL children also scored about four fifths of a standard deviation lower on vocabulary tests and about a third of a standard deviation lower on reading assessments than their Non-DLL peers.

[INSERT TABLE 1 HERE]

Procedures

In Fall 2002, children were randomized to an offer of Head Start treatment and control conditions *within* “centers,” without regard to age cohort. Participants and their parents were followed-up through grade 3. Children from the 3-year-old cohort treatment group were first offered enrollment in Head Start in Fall 2002, and the option to re-enroll for the second year of the intervention. Then, in year 2, both treatment and control groups from this cohort were offered enrollment in Head Start, in Fall 2003. Children from the 4-year-old cohort treatment group could first attend Head Start in the Fall 2002, for only a year. Children were tested on a battery of early language assessments in Fall 2002 (baseline) and in Spring 2003 (end of study year 1).

Measures

Below, I briefly define the measures included in my analysis, organized in groups as: outcomes, question predictor and mediator, and covariates.

- *Outcomes: Receptive Vocabulary and Early Reading Skills.*

My outcomes include single-indicator constructs measuring children’s early receptive vocabulary (*Peabody Picture Vocabulary Test-III (PPVT)*; Dunn & Dunn, 1997), and decoding skills (*Woodcock-Johnson Letter-Word Identification (LWID)*; Woodcock, McGrew, & Mather, 2001). The *PPVT* is an omnibus measure of early childhood language that requires children to name pictures or choose which of four pictures best represents a stimulus word. *LWID* is a standard achievement battery that measures children’s decoding skills and symbolic learning. From the former, I used the IRT-scaled scores (whose values ranged

from 154 to 401) as my outcome. For the latter, I used the W-score, established on an equal-interval scale (with values ranging from 264 to 408). Both tests are nationally-normed, have strong and documented psychometric properties, and have been used widely.

- Question Predictor: Randomized Offer of Head Start Treatment Assignment

I defined a dichotomous variable, *OFFER*, as a single-indicator construct distinguishing whether children were offered enrollment in the Head Start treatment group (=1), or control group (=0).

- Mediator: Parent-Child Language-and-Literacy Activities (*PCLITACT*)

My mediator, *PCLITACT*, is a total score on an observed composite defined by the six indicators included in my hypothesized model, in Figure 1. Responses to these indicators were obtained during interviews, when parents reported the frequency with which they engaged the focal child in diverse language-and-literacy activities. In choosing these particular indicators, I focused specifically on parent responses to six items that required dyadic, reciprocal interactions and joint attention on literacy. I used the following, preceded by a common question stem that asked *how often a parent or someone in the family*: (a) read to child (*READ*); (b) retold or made up stories (*STORY*); (c) worked on learning names of letters or words (*WORD*); (d) practiced writing the alphabet (*ALPHA*); (e) practiced writing and spelling name (*SPELL*); and (f) practiced rhyming words (*RHYME*). Each shared the same 6-point Likert-type ordinal response scale, which ranged from never (=0), once a month or less (=1), 2-3 times a month (=2), 1-2 a week (=3), 3-4 times a week (=4), and every day (=5). I conducted confirmatory factor analyses

(CFA) of parents' responses to these items and confirmed that they provided a unidimensional *Parent-Child Language & Literacy Activities* scale with moderately strong internal-consistency reliability (estimated Cronbach's alpha = .80). Using multi-sample comparison techniques, I also confirmed that the measurement structure of the construct was invariant across Spanish-speaking DLL and native English-speaking children, the treatment and control groups, the 3- and 4- year old-cohorts, and subsequent follow-up years. Having confirmed the psychometric properties of this measure, I unit-weighted and averaged item scores to create a composite score to represent the construct. The average parent response score across the six selected items was 0.58 ± 0.23 , ranging from 0 to 1. Higher scores indicated greater frequency of parent-child activities.

- *Covariates*

In all my analyses, I included selected exogenous covariates, measured at baseline (prior to randomization), either to capture the clustered nature of my research design (i.e., children within centers) or to increase the precision of my estimation and statistical power (i.e., pretest scores, child and maternal sociodemographic characteristics). These same covariates were reported by the primary caregiver, included in the analyses conducted by the original HSIS investigators, and have been shown to predict children's early cognitive and reading skills in other studies (Weiland & Yoshikawa, 2013; Wong et al., 2008). I corrected all my inference for the clustering of observations within centers. I define the covariates in detail in *Appendix Table 2*.

Data-Analysis

I addressed my first research question, in which I treated both parental activities and child vocabulary purely as outcomes (and therefore had no concerns about issues of internal validity) using only the methods of structural-equation modeling. To address my second and third research questions, where I did have concerns about the internal validity of my findings concerning causal mediation, I applied two different analytic methods: (a) the standard multilevel structural equation modeling (SEM) (Preacher, Zyphur & Zhang, 2010), and (b) an innovative new approach—Average Causal Mediation Effects (ACME)—devised by Imai and his colleagues, based on Rubin’s potential-outcomes framework. Below, I present these methods. I first describe how I used the traditional structural equation modeling approach to address all three research questions. Then, I describe how I replicated the analyses for RQ2 and RQ3, using the new approach.

Strategy 1—Multilevel Structural Equation Modeling (MSEM)

As my first estimation strategy, I used a *Multilevel Structural-Equation Modeling* (MSEM) approach (Preacher et al., 2010) to address my RQs, for several reasons. First, MSEM allows for simultaneous testing of the direct and indirect (mediating) effects of predictors on multiple outcome measures (Stage, Carter & Norma, 2004; Schumacker & Lomax, 1996). Thus, I can estimate the causal impact of treatment offer on two related yet distinct dimensions of early language and literacy simultaneously. Second, this model adjusts standard errors appropriately for the clustering of children within centers. Since children were nested within Head Start centers, I fitted my hypothesized model to data using the TYPE=COMPLEX command in MPlus version 7 (Muthén & Muthén, 2012). Additionally, I permitted non-zero correlations between the residuals of the mediator and

those of the child outcomes. I also tested the indirect associations between treatment offer and children's vocabulary and reading via parent-child language-and-literacy activities (Preacher et al., 2010). More specifically, I used the product of the estimates of the *a* (offer to activities) and *b* (activities to outcome) pathways to summarize the impact of each indirect pathway.

Following standard practices in the structural-equation modeling literature, I evaluated overall model fit using selected fit indices, including the: (1) χ^2 statistic, (2) Root Mean-Square Error of Approximation (RMSEA), (3) standardized root mean-squared residual (SRMR), (4) Comparative Fit Index (CFI), and (e) Tucker-Lewis Fit Index (TLI). Experts suggest that using multiple fit indices offsets the limitations of each index, since each summarizes a different aspect of fit (while CFI and TLI are incremental-fit indices, RMSEA and SRMR are absolute-fit indices). Typically, CFI and TLI statistics with magnitudes exceeding .90 signal acceptable fit, and estimates exceeding .95 or greater signal good fit (Hu & Bentler, 1999). The RMSEA and SRMR statistics assess a model's "badness of fit," by summarizing average differences between predicted and observed covariances among the variables included in the models. For the RMSEA statistic, estimates less than .05 indicate excellent fit and between .05 and .08 indicate reasonable fit (Kline, 2011). Lower values of SRMR indicate a good fit, when the value is less than .08 (Hu & Bentler, 1999).

RQ1: What is the causal impact of an offer of Head Start on parent-child language-and-literacy activities and children's vocabulary and reading skills?

To address my first research question, I fitted a reduced path model—the model displayed in Figure 1 *without* the hypothesized paths represented by the dotted arrows

included—and estimated regression parameters, γ_1 , γ_2 and γ_3 . These parameters then represent the total effect of an offer of Head Start on Parent-Child Language-and-Literacy Activities, children's PPVT, and Letter-Word Identification scores (denoted by the solid arrows in *Figure 1*). If estimates of these parameters are statistically significant and positive, then I can conclude that a randomized offer to enroll in Head Start improved both parent-child activities and children's vocabulary and early reading skills.

RQ2: Are the impacts of Head Start on early language and literacy skills mediated through its impact on parent-child language-and-literacy activities?

To test the impact of the mediational pathway, and investigate relationships among treatment offer, the mediator representing parent-child language-and-literacy activities, and early language outcomes simultaneously, I fitted the fully-mediated model in Figure 1, estimating the regression parameters representing both the direct effects (γ_2 and γ_3) and indirect effects ($g_1\beta_1$ and $g_1\beta_2$) through the mediator. If the estimated values of the direct impact of treatment on child outcomes (represented by parameters γ_2 and γ_3), are statistically significant and non-zero in the population, I can conclude that children who were offered Head Start scored higher on standardized language and literacy assessments, on average, via a direct path. Then, I assessed whether the indirect effects of treatment on vocabulary and early reading outcomes occurred through parent-child activities, in this model, by conducting the multivariate equivalent of a Sobel test (Sobel, 1982; 2008), contrasting the fit of a reduced model that contains no indirect paths and the current full model. I also estimated bias-corrected bootstrapped standard errors and confidence intervals to evaluate the statistical significance of the specific indirect pathways.

RQ3: Are these impacts and associations different for Dual Language Learners (DLL) compared to their non-DLL peers?

To address this question, I conducted multi-group analysis, by language status (DLL). Within the MSEM framework, multi-group analyses permitted me to detect the origins of group-related differences within the hypothesized path structure (Bollen, 1989). Multisample comparison is one way to address questions of moderated mediation such as the current *RQ3* (Preacher et al., 2007). Thus, I replicated my *RQ2* analysis, by refitting the hypothesized path model (Figure 1), now stratified by group. First, I fitted a baseline model in which I permitted all parameters to be estimated freely between groups. Then, I conducted sequential hypothesis tests across successive nested models where I constrained specific hypothesized relationships within each group to be equivalent across the two groups (specifically, by constraining: a) structural paths from treatment offer to each of the child outcomes, b) structural paths from offer to mediator, c) structural paths from mediator to outcomes, and d) indirect paths (i.e., “ab”) between groups). Finally, I fitted the most constrained model where I forced all paths in the hypothesized model to be equivalent across the two groups. From these comparisons, I examined the equivalence of competing mediating models and identified the structural pathway(s) by which associations among treatment offer, mediator, and outcomes may have differed by DLL status. My goal was to understand the extent to which paths that predict children’s vocabulary and reading skills might be similar or different, by group.

Strategy 2—Estimating Average Causal-Mediation Effects (ACME)

Most mediation analyses in psychology have been conducted using the classic SEM approach described above (Baron & Kenny, 1986; Bollen, 1987; MacKinnon,

2008) with less emphasis on explicit causal assumptions and modeling. Imai and colleagues (2011) have applied the SEM approach within the formal frameworks of causal inference to advance methodologies in mediation analysis. Their new approach also demonstrates that the potential outcomes framework can help us understand the key identification assumptions underlying causal mediation analysis.

Thus, in addressing threats to internal validity in my MSEM findings, I applied a second estimation strategy—Imai and colleagues' approach to estimating average causal-mediation effects (ACME) (Imai, Keele, Tingley, & Yamamoto, 2011). This analytic strategy relies on a conceptual framework to account for counterfactual causality and is conducted under Rubin's potential-outcomes framework. Counterfactual causality helps us to estimate the causal effect of treatment for child i in both treatment conditions (Rubin, 1974; Imai, Keele, Tingley & Yamamoto, 2011). If we were to imagine each child having two potential outcomes—the outcome value that the individual child would experience if offered a slot in Head Start, $Y_i(1)$, and the outcome values the individual child would experience when assigned to control, $Y_i(0)$, then the causal estimate of treatment effect is the difference between these two potential outcomes for child i .

The fundamental problem of causal inference (Holland, 1986) is that only one of the potential outcomes is observable for each person. Since the unit-level treatment is unobservable, researchers often estimate the average treatment effect (ATE), over a defined population. Estimation of causal effects in the context of randomized experiments can then be thought of as inferring valid estimates of the missing potential outcomes in order to obtain unbiased estimates of the treatment effect.

Imai and colleagues (2011) extended this idea of counterfactual causality to define effects related to intermediate posttreatment variables, such as mediators or measures of compliance measured between treatment assignment and outcomes— $M_i(1)$ and $M_i(0)$ to denote potential mediator values for a child i that would be realized in treatment and control conditions respectively. They developed an algorithm for estimating causal mediation effects using the potential-outcomes framework. Then, the causal mediation effect for the i^{th} child is:

$$\delta_i(t) \equiv Y_i(t, M_i(1)) - Y_i(t, M_i(0))$$

where $Y_i(t, M_i(1))$ is the observed parent-child language-and-literacy activities when a child i is assigned to Head Start, and $Y_i(t, M_i(0))$ is the potential value of the parent-child language-and-literacy activities under the counterfactual scenario where child i was still assigned to treatment, but his or her value of a mediator is as if the child was assigned to control. In other words, Average causal mediation effect (ACME) is an estimate of the average difference between the outcome predictions using the two different potential values of the mediator. In other words, ACME represents the average differences in the potential value of vocabulary and reading skills that are due to the change in the level of parent-child language-and-literacy activities induced by the differences in the treatment condition. Additionally, by fixing the treatment and changing only the mediator, I eliminated all other causal mechanisms and isolated the hypothesized mechanism, parent-child language-and-literacy activities in my models. In other words, holding the treatment variable constant at t eliminates the direct effect of treatment offer, which in turn, isolates the indirect effect of an offer on children's language and literacy that transmits through parent-child language-and-literacy activities from other alternative causal mechanisms.

Therefore, I am able to estimate the causal effect of an offer on children's vocabulary and reading attributable to the change in parent-child activities induced by treatment offer.

There are key assumptions that are critical to mediation analyses that employ the potential outcomes framework. I outline these assumptions and discuss their plausibility in the context of HSIS below.

Assumptions of the Causal Mediation Approach

In applying Imai and colleagues' (2010; 2011) approach to causal mediation in the potential outcomes framework, I must make two strong assumptions that are required to identify direct and indirect effects. Below, I outline these assumptions and discuss their plausibility in the context of HSIS data. They include: (a) *Sequential Ignorability* and (b) *the Stable Unit Treatment Value Assumption* (SUTVA).

- *Assumption 1: Sequential Ignorability*

Imai, Keele, and Yamamoto (2010) showed that one must satisfy the *sequential ignorability assumption*, in order to identify the ACME. This assumption has two stages, including: [1] assignment to treatment condition is random, and independent of each child's potential outcomes, after controlling for all relevant observed pretreatment covariates, and the assignment of mediator values is also independent controlling for observed treatment and the same set of covariates; [2] There are no unobserved mediator that would confound the results given the actual treatment status and pretreatment covariates.

$$\{Y_i(1), Y_i(0)\} \perp\!\!\!\perp T_i$$

If a child i has a high value of the (Potential) outcome, Y , that will not make him or her more likely to be assigned to treatment. This assumption implies that unobserved errors

are uncorrelated with assignment (or that random assignment was done correctly). The above equation on joint statistical independence states that the mechanisms for assigning children to either Head Start or control is “a known probabilistic function of observed values” (Jin & Rubin, 2009). Hence, the assumption of ignorable treatment assignment clearly holds given the randomization of treatment assignment in the HSIS. However, the second ignorability is untestable and a stronger assumption to make even in randomized experiments. While I address this by including a comprehensive set of pretreatment covariates collected prior to randomization, there might be unmeasured pretreatment or posttreatment covariates I did not account for that could confound the relationship between parent-child activities and child language and literacy outcomes.

The mediation analysis conducted in the SEM framework also relies on this key assumption (Imai, Keele & Tingley, 2010). However, while this assumption may appear to be similar to the usual exogeneity, or no omitted-covariate assumption, randomizing both treatment and mediator does not satisfy the sequential ignorability assumption. Even after the randomization of treatment and mediator, I cannot identify mediation effects without imposing an additional assumption (Imai et al., 2011). Therefore, conducting mediation analysis in the potential-outcomes framework clarifies the challenge that need to be addressed, which is less apparent in the traditional SEM framework.

- *Assumption 2: Stable Unit Treatment Value Assumption (SUTVA)*

The SUTVA assumption has three essential components. The first is an assumption of no interference. This assumption implies that the observed outcome for each child is a function of the potential outcomes and random assignment, and is *not* independent on the assignment of other children. That is, the treatment assignment of child i cannot impact

the outcomes of child j , for all i, j . The other two components assumes that there is no variation in the available treatment across individuals and no variation in the available control settings.

RQ2: Are the impacts of Head Start on early language and literacy skills mediated through its impact on parent-child language-and-literacy activities?

Suppose that we are interested in estimating the ACME under the treatment, T. First, the outcome is predicted under T using the value of the mediator predicted in the T condition. Second, the outcome is predicted under the T condition but now uses the mediator prediction from the control condition. To address this question, using the innovative methods of Imai and his colleagues, I employed an algorithm, consisting of two steps.

$$M \text{ model} = F(x) T + \text{Cov} \text{ (#1)}$$

$$Y \text{ Model} = F(x) M + T + \text{Cov} \text{ (#2)}$$

First, I fitted regression models in which parent-child activities and vocabulary were outcomes. I modeled the mediator, parent-child activities, as a function of treatment and relevant pretreatment covariates (equation #1). Then, I modeled the vocabulary outcome as a function of the mediator, the treatment, and the pretreatment covariates (equation #2). Based on the fitted mediator model, I generated two sets of predictions for each child, one under the treatment and the other under the control condition. Then, I used the fitted outcome model (equation #2) to predict the potential outcomes for each child, under both the treatment and control conditions. I estimated the causal mediation effect for vocabulary as the average difference in predicted vocabulary outcome that is due to

the change in the level of parent-child activities induced by the differences in the treatment condition. Then, I repeated the same set of analyses for the reading outcome.

RQ3: Are these impacts and associations different for Dual Language Learners (DLL) compared to their non-DLL peers?

To address *RQ3* using my second estimation strategy, I replicated my *RQ2* analysis described above, by refitting the model, separately for the DLL and Non-DLL sub-samples.

Results

RQ1: Simultaneous Causal Effects of the Treatment Offer on Both Parent and Child Outcomes

In Figure 2, I display the path model estimating causal effects of Head Start treatment offer on parent-child activities and child language and literacy outcomes. Results of MSEM analyses for *RQ1* demonstrated adequate overall model fit ($CFI=.97$; $TLI=.92$; $RMSEA=.04$.; $SRMR=.05$). An offer of treatment also increased the frequency of parent-child language-and-literacy activities by .06 points, corresponding to a moderate effect size of .25 of a standard deviation. This is a small impact given that being offered a slot in Head Start shifted parent-child activities by a quarter of a standard deviation to the right. Based on the path estimates, being offered enrollment in Head Start caused an increase in children's vocabulary and reading scores, on average, of 5 and 6 points respectively. Effect sizes were as follows: 0.13 for receptive vocabulary (PPVT) and 0.17 for early reading (Letter-Word Identification).

[INSERT FIGURE 2 HERE]

RQ2: Effect of the Treatment Offer on the Child Outcomes, Mediated by Parenting Activities

For this research question, I present and compare findings from both data-analytic strategies—MSEM and ACME—in parallel. In general, I found that the two approaches to modeling and estimation provided very similar results, in terms of both direction and magnitude.

First, I display results for the fully mediated MSEM model in Figure 3. Here, I found that higher levels of parent-child activities predicted higher scores in vocabulary directly, $b=14.5$ (2.553), $p<.001$, and letter-word skills, $b=16.2$ (2.125), $p<.001$. In addition, the indirect effect of the Head Start offer on vocabulary through parent-child activities was 0.81, or 14 percent of the total treatment effect. The indirect effect of the offer on letter-word reading skills through parent-child activities was 0.91, or 18 percent of the total treatment effect. That is, I estimate that close to one-fifth of the total treatment effect on reading skills was mediated through parent-child activities. I also conducted hypothesis tests of the indirect effects on child outcomes, and was able to reject the null hypotheses associate with the indirect relationships between the offer and vocabulary ($p<.001$), and letter-word identification ($p<.000$) via parent-child activities.

[INSERT FIGURE 3 HERE]

In Figure 4, I display estimated parameters, standard errors and approximate p-values for the same direct and indirect paths, using the ACME approach to estimation. The findings are consistent with the estimates obtained under the MSEM approach. For vocabulary, I estimated that close to 12 percent of the total effect is causally mediated through parent-child literacy activities ($b=0.484$, [.262, .776]). For letter-word, I

estimated that close to 11 percent of the total effect is causally mediated through parent-child literacy activities ($b=0.473$, $[-.273, .719]$). I tested the corresponding null hypotheses using the obtained confidence intervals and was able to reject the null hypothesis in each case.

[INSERT FIGURE 4 HERE]

RQ3: Effect of the Treatment Offer on the Child Outcomes, Mediated by Parenting Activities, by Language Status

First, consider estimates obtained under the MSEM strategy. I compare the differences in the main effects on parent-child activities and child language and literacy between DLLs and Non-DLLs based on the respective parameter estimates and effect sizes. Then, in Figures 5 and 6, I present the estimated differences in mediated effects for vocabulary, then for reading skills, by DLL status. The impact of an offer on parent-child language-and-literacy activities was 0.08 point for parents of DLLs and 0.05 point for parents of Non-DLLs. When comparing direct impacts of assignment, an offer of participation in Head Start increased children's vocabulary scores by close to 10 points, on average, for DLLs, but by only 3 points, on average, for Non-DLLs. Thus, —the vocabulary impact for DLLs was approximately three times that for Non-DLL. For reading skills, the offer increased about 3 points for DLLs and over 4 points for Non-DLLs, on average. Based on the results from the MSEM models, 12% of the total impact on vocabulary were mediated through parent-child language-and-literacy activities for DLL, compared with 18% for non-DLLs. More than a third or 37% of the total impact on reading were mediated through parent-child literacy activities for DLL, compared with 14% for non-DLLs. The Sobel tests for the mediational effect on both vocabulary and

reading showed significance at the .05 level.

[INSERT FIGURES 5 and 6 HERE]

These findings were consistent with estimates obtained in the causal-mediation analyses, by language status (Tables 4 and 5). For vocabulary, the impact of an offer on parent-child language-and-literacy activities was 0.774 points for parents of DLLs and 0.384 points for parents of Non-DLLs. When comparing direct impacts of assignment on vocabulary, the offer increased close to 10 points for DLLs, but 2 points for Non-DLLs, on average—the vocabulary impact for DLLs was over five times larger than that for Non-DLL. For reading skills, the treatment offer on parent-child activities was over 1 point for parents of DLLs and 0.341 points for parents of Non-DLLs. The offer increased about 4 points for both DLLs and Non-DLLs, on average. I estimated that 8% of the total effect on vocabulary was causally mediated through parent-child literacy activities for DLLs ($b=0.774$, [.222, 1.462]), compared with close to 20% for Non-DLL ($b=0.384$, [.156, .681]). For reading skills, over 26% of the total impact on reading was causally mediated through parent-child literacy activities for DLLs ($b=1.024$, [.466, 1.735]), compared with 8% for Non-DLL ($b=0.341$, [.147, .579]). Causal mediation effects on vocabulary and reading for both groups were statistically significant and positive.

[INSERT FIGURES 7 and 8 HERE]

Furthermore, while the total effect of treatment offer on vocabulary was substantially larger for DLLs compared to Non-DLLs, only 12 percent of its effect was mediated through parent-child activities. In contrast, an indirect effect made up almost one-fifths of total vocabulary effect for Non-DLL (18.7%). This story flips on its head

when I examined reading skills. However, 37 percent of total effect was significantly mediated through parent-child activities for DLL, but just about 14 percent for Non-DLL.

[INSERT TABLES 4 and 5]

Sensitivity Analyses

Imai and colleagues (2011) offer suggestions for conducting sensitivity analyses to accompany their method of causal mediation analyses. Given that identification of causal mechanisms relies on an untestable assumption, it is important to evaluate the robustness of my results to the potential to presence of an unobserved pretreatment confounder(s), referred to as violation of sequential ignorability. Specifically, this sensitivity analysis can shed light on whether the estimates obtained under sequential ignorability are robust to the presence/absence of possible hidden pretreatment confounders.

The sensitivity analysis that Imai and colleagues (2011) proposed is based on the value of the bivariate correlation (ρ) that may exist between the residual (error) on the mediation outcome (parental practices), and the residual (error) on the ultimate outcome (child vocabulary) (see Figure 1). Imai and his colleagues argued as follows:

- If the assumption of sequential ignorability holds, then the correlation between the two residuals terms will be zero, and I have accounted for all pretreatment confounders.
- Nonzero values of the correlation ρ imply departures from this assumption and suggest that some hidden confounder is biasing the ACME estimate. Thus, the value of ρ can serve as a sensitivity parameter, because more extreme values of ρ represent larger departures from the sequential-ignorability assumption.

While the true value of p is unknown, Imai and colleagues (2011) proposed a possible way to estimate the values of p for which the ACME is 0, or its confidence interval contains 0.

[INSERT FIGURES 11 THROUGH 16]

For the causal-mediation effect of an offer on vocabulary via parent-child activities, the value of p was 0.08 and also non-zero for DLLs ($p=.09$), and for Non-DLLs ($p=.08$). For the causal mediation effect on reading skills, the value of p was 0.11 and also non-zero for DLLs ($p=.15$), and for Non-DLLs ($p=.10$). These results are presented in Figures 11-16. In all these plots, the true ACME values are plotted against values of the sensitivity parameter, p , and thus represents both the degree and direction of the unobserved confounding factor between parent-child activities and child outcome. The shaded region in the plot represents the 95% confidence intervals for each value of p .

These sensitivity analyses raise questions on whether the estimates obtained under sequential ignorability are robust to possible hidden pretreatment confounders. However, Imai and colleagues (2011) note that their proposed method is designed to test the sensitivity to the presence of an unobserved pretreatment confounder but does not address the possible existence of confounders affected by the treatment offer and then confound the relationship between the parent-child activities and children's language and literacy.

Discussion

In this research, my goal was to examine a construct that is prominent in Head Start's theory of change and performance standards, but underexplored in the research literature—parent-child language and literacy activities—as a potential mediator of effect of an offer of participation in the program on child language and literacy. Moreover I

examined how these meditational patterns may differ for DLL vs. non-DLL students. This is one of the first empirical studies to investigate the causal impact of being offered a slot in Head Start on a psychometrically valid, multi-item construct of parenting practices that may matter directly for young children's language and literacy development. In addition to Sobel's standard approach to mediation, I implemented Imai et al.'s approach to causal mediation to test whether parent-child literacy activities operated as a causal mechanism through which an offer of Head Start impacts the child's language and literacy outcomes. Across both sets of analyses, the story is similar and clear. An offer of participation in Head Start is indeed effective in increasing parents' investment in their child's early language and literacy development, particularly among parents of Dual Language-Learners (DLL). Furthermore, while an offer of participation in Head Start is effective in improving Spanish-speaking DLL children's English vocabulary and reading skills, different mechanisms seem to be at work, depending on the specific domains of emergent language and literacy. Below I provide possible explanations to make meaningful sense of my key findings.

Why Head Start Might Increase Parental Investment in Early Learning

In this study, the offer of participation in Head Start increased the frequency of parent-child language-and-literacy activities for the overall sample by a quarter of a standard deviation. The randomized offer to enroll in Head Start led to improvements in the parent-child activities composite variable of roughly a third of a standard deviation for DLL children, compared with just less than a quarter of a standard deviations for non-DLL children. These findings are comparable to that of York and Loeb (2014)—where the effect of the READY4K! texts on parents' global early literacy practices was about

0.29 standard deviations. Recent large-scale evaluations of publicly funded preschool have found stronger impacts on language and literacy for DLL background students compared to non-DLL students (Gormley et al., 2005; Weiland & Yoshikawa, 2013). In addition, the HSIS found this pattern as well. My findings further support Gelber and Isen's (2012) conclusions that showed positive impacts of attending Head Start on a variety of parent investment outcomes. However, they analyzed whether the impacts of participation in Head Start on single items measuring parent investment were different across demographic groups and found no evidence of different impacts across any of the subsamples of children (i.e., whether the biological dad was home, child's gender, parent income at baseline, number of siblings). However, few studies have proposed whether differential effects on parents might explain stronger impacts for DLL students. My findings suggests that there are in fact stronger effects on parent-child language-and-literacy activities for DLL families than for non-DLL families, and that in the case of early reading skills, the pattern of mediation through this construct is stronger for DLLs than non-DLLs.

There are four theoretical explanations for why of an offer of participation in Head Start might be effective at increasing parent-child activities, particularly among Latino immigrant parents. The four hypotheses are not mutually exclusive. First, the *transactional model* helps us understand that a child attending Head Start as a result of having been in preschool might show improved language or cognitive skills, which in turn can elicit different kinds of parent-child interactions and activities at home. This view acknowledges the proactive role of the child in precipitating differentiated behaviors of their parents (Bell, 1968; Bornstein, 2009). Hence, changes in parenting

behavior may be in part contingent on the behavior of the child attending Head Start. If there were fairly low levels of literacy activities at home, for example, then a child attending Head Start might engage his or her parent in certain kinds of language-and-literacy activities they have been exposed to in preschool; they might talk about how much they enjoy their teacher reading to him or her or solicit their parents to engage in activities they learned in school at home. Children and contexts influence each other mutually over time, so that the change a child precipitates in the environment will influence how the environment in turn shapes the child at a later time point (Sameroff & Chandler, 1975).

Similarly, my findings support Gelber and Isen's (2012) hypothesis of the impact of Head Start on parent investment: parents could perceive their involvement in their child's early learning experiences as *complementary* to observed changes in child characteristics that result from enrolling in center-based preschool. My findings confirm that low-income parents increase and sustain their concerted effort to engage their child in learning activities to early learning opportunities their child may access in preschool. A possible explanation could be that children who acquire new learning experiences may bring different expectations and request when interacting with their parents at home. A future study could explore whether differential levels of academic engagement among children in classrooms is related to the frequency or quality of parent investment approaches at home.

Another explanation could be that participation in Head Start provides a unique setting to help low-income parents establish a sense of authenticity and cultivate "*possible selves*" (Oyserman, Bybee & Terry, 2006) in their role as their child's teacher.

Possible selves are positive and negative images of the self with a future orientation.

From its inception, Head Start functioned as a two-generation model by engaging low-income parents directly in its governance, developing parent leadership and social networks among parents, and providing new opportunities for parents to observe and participate in classrooms. Head Start performance standards focus explicitly on promoting family literacy activities as a goal for the parent-focused components of the program. The theoretical model of possible selves (Oyserman, Bybee & Terry, 2006) can be applied to understand how and when low-income and/or immigrant parents encounter transformational experiences in the context of participation in Head Start, and how their possible selves impel parents to engage in enriching learning activities at home with their children. Oyserman and colleagues (2006) argue that possible selves alone are never sufficient unless linked directly with plausible strategies and social-context supports that make individuals feel like “true” selves and connected with their social identity and self-perception. They also describe that possible selves fail to sustain a self-regulatory approach when they conflict with other aspects of self-concept. These possible selves develop through symbolically mediated, collaborative interaction with others and contextual cues from the social environment (Markus & Kitayama, 2010).

As a consequence of participating in Head Start, parents may begin to link tangible teaching strategies and new ways of interacting with their child to their possible selves. That is, participation in Head Start may be providing an environment where their social and personal identities feel congruent with these new teaching practices they are adopting thereby changing the meaning parents used to associate with difficulties and hardships in pursuing more positive parenting practices. However, there are several

factors that threaten persistently low-income parents' ability to sustain self-regulatory effort over time—stereotype threat, psychological distress related with economic hardship, and environmental stress (i.e., low-wage work). Regardless, my findings support this view that participation in Head Start may make cultivate possible selves through its multi-pronged parent engagement efforts to transmit culturally responsive and accessible strategies for promoting early language and literacy. Without easily accessible models, parents may maintain an abstract commitment to supporting their children's early learning without connecting their possible selves to everyday parenting behavior, expressing high aspirations even as their behavior reflects avoidance or even flight from "school." As parents volunteer in classrooms, make curricular decisions, gather in parent group meetings, and experience home visits, these experiences may provide new ways to interpret themselves in their parental role, and integrate practices that promote early learning as a reasonable and attainable goal.

Third, increased pressure and exposure to the importance of school readiness, competitiveness, and acquisition of preacademic skills via participating in Head Start might influence parenting goals and investment strategies in expanding learning opportunities at home. Connecting with other Head Start parents or increased exposure to high-involvement parents could lead parents to change their behavior as well. Head Start parents receive a variety of messages from Head Start staff in the form of resources, materials, and guides. Parents of children attending Head Start, for example, receive a variety of ACF-sourced materials that support information on how parents might invest in early learning at home. Some of these materials include, "Tips for Helping Children Learn to Read," "Brain-Based Parenting," "How Can Teachers and Parents Help Young

Children Become (and Stay) Bilingual?”, “Parents and Families as Teachers,” and “Heart to Heart: Ideas for Building Strong Ties Between Parents and Young Children.”

Studies indicate that increased parents’ knowledge and beliefs about child development mediated the effect of socioeconomic disadvantage on mothers’ speech to children (Rowe, 2008). Another hypothesis to consider is that participation in Head Start increases the social desirability of parents to engage in teaching / language and literacy activities with children. The increase in social desirability might be linked to children’s language outcomes through some other mechanism. Additionally, parents often use the word, “school” for describing center-based preschool education. Parents might also perceive their children having “won a lottery” to attend “school,” which could foster parents’ academic orientation and change their behavior to ensure that their kids may do well in school.

Lastly, participation in Head Start may increase parental investment in early learning by reducing parenting stress and helping parents make decisions that promote children’s language and literacy. Scientists find that the circumstances of living in poverty can overwhelm critical thinking and undermine decision-making skills among low-income parents (Mullainathan & Shafir, 2013). Head Start as an antipoverty program might help alleviate the level of psychological stress parents experience. Based on an emerging body of evidence in brain science, the stresses that come with being poor affect negatively the strategic thinking and self-regulation skills that parents need in order to break the vicious cycle of poverty. These executive functioning (EF) skills are fundamental to the ability to solve problems, multitask, manage competing priorities, control impulses, delay gratification, and persist in pursuit of goals. While poverty

compromises EF skills, participation in Head Start might help relieve parenting burdens and enhance the quality of decisions parents make at home. Participation in Head Start offers a comprehensive set of social services and mental health components to mitigate the severity of psychological stress parents may experience as they juggle multiple demands in supporting their child's early learning. Head Start programs must secure the services of mental health professionals and provide on-site mental health consultation with program staff and parents. Mental-health staff consultants engage in a variety of prevention efforts, not just treatment (Yoshikawa & Knitzer, 1997). Classroom-based mental-health consultation services in Head Start were effective in reducing disruptive problem behaviors (Gilliam, 2008).

Head Start Performance Standards further necessitate preschool-home collaboration in supporting child mental health: Discussing observations of children and concerns with parents, helping parents to better understand mental health issues, and supporting parents' participation in any mental health interventions, for example. Additionally, programs, through the work of family service staff, must partner with parents to identify family goals, timetables, strengths, and necessary supports soon after enrollment. Head Start performance standards also stipulate grantee and delegate agencies to help parents to identify and access continually—directly or through referrals—services and resources that are responsive to parents' goals, including: “crisis assistance in areas such as food, housing, clothing, and transportation,” “opportunities for parents to participate in counseling programs,” “opportunities for continuing education and employment training,” nutrition counseling, and mental health interventions. Group socialization activities for parents further provide opportunities for social connectedness

and a broader local base of support. Provision of all these services may help reduce burdens associated with parenting directly by addressing behavioral or mental health needs of the target child, and/or indirectly by equipping parents to access necessary resources in meeting their own goals.

In summary, these hypothesized mechanisms could have contributed to establishing cultural congruence of language environments between home and preschool, and bridging home-school difference in interaction further enhanced children's engagement and level of participation in classroom instruction. *Abriendo Puertas* was effective because it incorporated strategies that have been identified as promising in other interventions targeting Latino families and children, including: integration of Latino culture in the program curriculum, the program's focus on the family, and the use of Spanish-speaking facilitators. Future studies can investigate variations in impacts of participation in Head Start attributable to center characteristics and practices that are associated consistently with building parenting capacities, particularly for parents of Spanish-speaking DLLs.

The DLL Story: Explanations for Mechanisms of Head Start on Vocabulary vs. Reading

In this paper, I also investigated whether the mediation through parent-child language-and-literacy activities differed for DLL children and Non-DLL children. I found that 12% of the total impact of an offer of participation in Head Start on vocabulary was mediated through parent-child language-and-literacy activities for DLLs, compared with 18% for non-DLLs. And for reading, 37% of the total impact of the offer was mediated through parent-child language and literacy activities for DLLs vs. 4% for non-DLLs. Here, I provide theoretical explanations for why different magnitudes of the

mediational effect of Head Start might be at work in producing substantially larger effects of the offer on vocabulary vs. reading among Latino DLLs. *First, what might explain the substantially larger impact of the offer on English vocabulary among DLLs?* I suggest three hypothesized mechanisms: [1] Increased exposure to English instruction in preschool classroom that compensated for limited prior exposure to English, [2] a cognitive advantage of bilingualism, and [3] positive peer interactions that mediated the effect of English exposure in Head Start classrooms on Spanish-speaking DLL's English vocabulary and letter-word skills (Palermo & Mikulski, 2014).

Researchers have shown that low-income, Spanish-speaking DLLs may experience more rapid growth in word reading and oral-language skills than their non-DLL peers, given good quality classroom instruction (Mancilla-Martinez & Lesaux, 2011). Bloom and Weiland further tested two hypotheses for observing larger-than-average effects of an offer of Head Start for DLL that the stronger effect detected for DLL might reflect [1] a compensation for limited prior exposure to English or [2] a bilingual developmental advantage. The first hypothesis is based on the fact that pretest-based subgroups are confounded with language-based subgroups so that DLL children were far more likely than other sample members (i.e., mostly Black and White children) to be low pretest performers (i.e., those with a PPVT pretest score that falls within the lower third of pretest PPVT scores for DLL control group members) (65.0 versus 25.2, respectively). The second hypothesis is based on the neuroscience and psycholinguistics literatures, which support the cognitive advantages of bilingualism. That is, differences in brain organization as a result of bilingual learning predict more rapid literacy acquisition and better executive functions in young DLL children (Luo, Luk & Bialystok, 2010;

Carlson & Meltzoff, 2008). Aligned with Bitler and colleagues' (2014) conclusions, Bloom and Weiland (2015) suggest a compensatory pattern of Head Start effects for those with limited prior exposure to English, and a “dual-language learning advantage” for low pretest-performers. Further, differences in local Head Start programs, differences in local alternative programs (counterfactual care settings), and differences in their propensities to choose these options did not explain the striking subgroup differences in causal effects of an offer of Head Start between DLL and Non-DLL.

Third, Palermo and Mikulski (2014) further report that positive peer interactions in Head Start classrooms had positive effects on DLL children's English oral proficiency and learning behaviors (attentiveness, independence, initiative, persistence, participation). Given these findings, increased exposure to English as a language of instruction *and* as a language of peer interactions seem particularly important in improving English vocabulary development among Latino DLL.

Finally, *what might explain such a large indirect effect on reading skills among DLLs?* I present several explanations for why $\frac{1}{4}$ to $\frac{1}{3}$ of total effect of an offer of treatment on reading appeared mediated through parent-child language and literacy activities. DLL parents in the HSIS were almost entirely Spanish-speaking and 60 percent were recent immigrants (foreign-born and lived in the U.S. 10 years or less). It is plausible that low-income, Spanish-speaking parents' background in prior schooling and formal literacy instruction might have emphasized the mechanics of decoding over comprehension and conceptual knowledge, which could have influenced them to focus on decoding-related skills with their children at home. Parents of Spanish-speaking DLL children represent sending countries where there is a heavy emphasis on rote instruction

in primary education (of which Mexico is most prominent among Spanish-speaking countries, and also Central America, Dominican Republic, and Cuba). That is, this might be a reflection of what parents perceive as “academic” and “rigorous;” the services and messages provided by Head Start may have been particularly likely to be interpreted by these parents as a request to formally “teach” their children early literacy skills in English.

We also know from prior research (Robins, Treiman, Rosales, & Otake, 2012) that low-income immigrant parents prepare their kids for “school” by emphasizing letter knowledge and recognition, whereas higher income and native-speaking parents tend to focus more on word knowledge and familiarity with bookreading. Teaching the conventional alphabetic sequence—learning to sing or recite the alphabet in order—does not explain as effectively as clarifying the order of letters and sounds in particular words the function of letters. Low-income parents, in general, focused more on alphabetic order when talking about letters, and may direct their children toward less relevant aspects of emergent literacy (Robins, Treiman, Rosales, & Otake 2012).

Additionally, a recent study showed that English vs. Spanish-speaking parents hold different beliefs about bilingualism and language development. Spanish-speaking parents rely on an interdependent family structure for promoting early language and literacy and also believe in the importance of explicit language modeling for their child (Mancilla-Martinez et al., 2010). In comparison to English, Spanish has an orthographic system that is transparent (phonetic) in reading and spelling, and therefore for which decoding skills are particularly important. Parents’ beliefs about explicit language modeling and their own literacy experiences could have influenced a heavily emphasis on

phonological perception and decoding skills (i.e., letter-word identification). Supporting preschoolers to acquire print knowledge requires different teaching strategies; supporting vocabulary growth requires greater quantity and elaboration of talk, and exposing the child to novel experiences and contexts with exposure to more rare words, not just common words. Parents' effortful teaching of print-specific skills and engaging in letter- and sound-focused activities could have influenced children's print knowledge skills (i.e., letter-word identification) (Whitehurst & Lonigan, 1998). Another study confirms that in comparison to African American parents, Latino parents provided more teaching support for their children's letter-word identification skills than for vocabulary (Tamis-LeMonda, et al., 2014).

Furthermore, some recent studies suggest that learning Spanish might play a more direct role in supporting emergent reading skills than in supporting vocabulary development among Latino DLLs. Tamis-LeMonda and colleagues (2014) found that children's language growth—from ages 2 to 5—in English predicted their expressive vocabulary at age 5, whereas their growth in Spanish predicted their letter-word identification. Another study suggested that Spanish vocabulary predicted Spanish-influenced spelling while English vocabulary predicted orthographically plausible English spelling, which point to the importance of oral language as a determinant of literacy skills (Rolla San Francisco et al., 2006). Finally, Palermo and Mikulski (2014) report that DLL children's English oral proficiency mediated the association between positive peer interactions and English vocab skills. DLL children's learning behaviors mediated the association between positive peer interactions and English letter-word skills.

Limitations

My research has conceptual and empirical strengths, including, [1] I use a more reliable measure of parenting behavior that matter for children's learning, [2] I analyze a large, nationally representative sample of low-income children across the U.S., [3] I examine mediation effects on two related yet distinct domains of early language and emergent literacy—vocabulary and reading skills, and [4] I apply innovative causal-mediation methods to establish causality links between treatment offer, parent-child activities, and children's language and literacy outcomes.

However, I point out several limitations. First, parents self-reported their responses on the parent-child language-and-literacy activities scale. While frequency alone is one aspect of parenting central to children's early language and learning (Tamis-LeMonda & Rodriguez, 2014), I cannot say much about the quality or the content of the parent-child interaction around language-and-literacy activities such as maternal elaboration of storylines, the number of conversational turns during parent-child book reading, or questions parents elicit about different story content (dialogic emphasis). Next, I recognize the potential bias to my estimates introduced by social desirability among parents to report greater frequency in engaging in these activities than their actual practice. Third, I cannot generalize fully these findings to the population of Head Start children due to potentially non-random missing data and attrition. I included only those for whom I have outcome data on children's vocabulary scores and parenting rating of the parent-child language-and-literacy scale.

More importantly, there are no established methodological approaches to investigating causal mediation in the Treatment-on-the-Treated (TOT) framework. This

becomes particularly more challenging with the complicated structure of the HSIS dataset. To my knowledge, implementing the TOT analysis using Imai and colleagues' (2010; 2011) approach in the HSIS is not feasible at this point. Although I acknowledge the importance of examining the impact of participation, not just an offer, through an additional set of TOT analysis, the principal focus of my study is on the issue of mediation of the impact of an offer of treatment on child outcomes, not the dose-response relationship between participation in Head Start and the outcome.

Finally, a limitation of the HSIS dataset is that Latino DLL children were tested in English only. It would have been interesting to compare the findings to their performance in Spanish assessments (i.e., *Test de Vocabulario en Imagenes Peabody* (TVIP), *Woodcock-Muñoz Language Survey-Revised* (WMLS-R) *letter-word identification*). In the HSIS, DLL were defined as children whose preferred dominant language was Spanish, as reported by their parents and Head Start teachers (DHHS, 2010). Whereas DLL were assessed in both English and Spanish at baseline, unfortunately, they were assessed only in English by the end of the first follow-up year. Additionally, it is questionable whether provisions for assessing DLL were adequate, and whether different decisions were enforced appropriately for English-speakers and bilingual DLLs. To conduct purposeful assessments aligned with early education programs, researchers must begin with a more nuanced and representative picture of who these children are and the language contexts that shape children's language exposure and interactions (Snow & Oh, 2010). Snow and Oh (2010) further argue that due to differing levels of exposure and experiences to a first language (L1) and a second language (L2) in home as well as other environments, these bilingual children possess differing patterns of language dominance.

Understanding the child's early language experience, particularly the home language environment and specificity of interactions in both languages is critical when assessing oral-language proficiency (Oh, Yoshikawa, Tamis-LeMonda & Song, 2013).

Given that bilingual children typically demonstrate a slower rate of vocabulary growth in either language than monolingual children (Hoff & Elledge, 2005), my findings appear to be more promising. While a considerable proportion of Spanish-speaking DLLs is represented on the bottom quartile in baseline language and literacy assessments, bilingual children's rates of early vocabulary acquisition fall within the range reported for same-age monolingual counterparts when their performance in both languages is considered (Pearson, Fernandez, & Oller, 1993). Scholars who study Latino DLL children's Spanish (L1) and English language (L2) acquisition confirm that these processes are interdependent and mutually supportive (Snow et al., 1998), and further, children's growth in English and Spanish vocabulary did not overlap; rather, their growth in Spanish vocabulary contributed an unique addition to their English vocabulary knowledge (Song, Tamis-LeMonda, Yoshikawa, Kahana-Kalman, & Wu, 2012).

Future Directions for Research, Policy and Practice

There are some important implications here for early childhood research, policy, and practice. Evidence supports pathways of early childhood education programs operating through both families and schools. A strong evidence base supports the importance of attending to both home and classroom settings if we are to effectively support the reading success of children (Dickinson & McCabe, 2001). Yet, too little attention is paid to integrating families when designing and implementing early childhood education programs. I conclude that the role of parenting and families present

promising policy levers that are understudied in these preschool evaluation studies. In my study, I found that an offer of participation in Head Start programs was effective in increasing parent-child language and literacy activities. This impact appeared larger for parents of DLL students and therefore could have potentially expanded opportunities for early learning at home. Greenfader and Miller (2014) tested for differences in Head Start attendance and center quality ratings between Spanish-speaking DLL children and English-speaking peers in the HSIS, and found that DLLs were more likely, on average, to accept the offer and attend Head Start if given access through random assignment. They found that Head Start appears to be a particularly appealing center-based care option for parents of DLLs in neighborhoods where they were clustered in large numbers. This might suggest that Head Start might be particularly effective in connecting with this population and strengthening the access to Head Start centers for Spanish-speaking DLLs. These hypotheses reinforce the findings from the HSIS that children whose home language was Spanish were more likely to return for a second year of Head Start ($p < .05$; U.S. DHHS, 2010). These results suggest that Spanish-speaking DLLs are not only more likely to accept the initial randomized offer of Head Start but remain enrolled in Head Start for a second year compared with other subgroups.

Future directions for research can further investigate the importance of explicitly encouraging developmentally appropriate, culturally responsive, learning activities for parents. Additionally, programs should track whether parent involvement in specific program offerings are related to parents' engagement in language and literacy activities at home. Currently the Head Start performance standards and training do not name these activities explicitly. While Head Start are required to promote family literacy

development, directly or indirectly through referral, Head Start staff would benefit from specifications of behavior strategies that have been proven effective, and linked to technical support to encourage these strategies in a manner that is accessible and culturally relevant to diverse groups of families. Efforts to establish cultural congruence across early learning environments must be emphasized when policymakers consider expanding and improve the quality of early child care and preschool programs. Early childhood researchers and practitioners alike acknowledge an urgent need to understand home environment factors that influence literacy development among Latino DLL children (Scheffner Hammer, Jia, & Uchikoshi, 2011). My work in progress will examine ethnic variations in early language environments and levels of language exposure in English and Spanish among Latino DLL children.

Furthermore, advancing the science of studying mechanisms of ECE is critical as the field moves forward in expanding access to high-quality early care and education for our society's most vulnerable children. Efforts to intentionally building adult capacity in home and ECE program settings is critical. Although not easy to confirm, persistent parent investment in early learning could be one mechanism through which long-run impacts of early childhood programs are mediated and sustained over time (Gelber & Isen, 2010). While cognitive and academic gains, on average, fade away shortly after completing preschool (Leak et al., 2013), building parent capacities may potentially sustain ECE impacts over time. Sophisticated understanding of how these mechanisms differ for diverse groups of children can further inform programmatic efforts and better equip the early childhood workforce. Learning how cultural values inform parent beliefs and practices about supporting literacy development seems particularly important. First,

this can help researchers to design more ecologically valid measures of home literacy environments and parenting practices, particularly those that include collective contributions of older siblings, grandparents, and other adults in promoting early language and literacy. Second, such efforts can also inform how practitioners connect with families to providing a more culturally congruent transition from home to preschool. Improving diverse contexts of early development (beyond the classroom) must be an explicit focus of the early childhood policy agenda.

Persistent parental investment could build on early acquisition of knowledge and skills and better prepare children for subsequent schooling. To date, parenting programs fall into one of two broad areas: improving skills or providing supplementary services. I argue that the field needs to reimagine this current paradigm on parent education as decades of research show “training parents” simply does not work. Now is the opportune moment for ECE researchers to fully engage low-income, racial minority parents as co-participants in designing interventions and as co-constructors of new knowledge the field desperately needs. Currently, design-based implementation research is lacking in the early childhood space and can offer promising directions for transforming existing models of parent training. There exist unprecedented opportunities and unparalleled challenges for the ECE field: We need to do much more than expand and improve the quality of preschool and child care. I would contend, given the strong evidence, that supporting families to enhance parenting investment in early learning is key to thriving societies. We must elevate the importance of equally investing in families and improving the quality of parenting in the national consciousness. This means, the field needs to rethink fundamentally our persistent notion that educational challenges should be solved

by schools alone (Reardon, 2013). This parenting gap is both a consequence and a cause of systemic inequalities and must be explicitly addressed as part of the early childhood policy agenda that recognizes the contribution of parenting to socioeconomic mobility, educational opportunity, and democratic participation.

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Figures & Tables

Figure 1. Path diagram describing hypothesized associations among a randomized offer to enroll in Head Start, a latent factor representing a potential mediator (parent-child language-and-literacy activities) and a pair of single-indicator literacy outcomes (vocabulary, and emergency reading skills), for children at the end of the first follow-up year, controlling for selected covariates (n=3,578).

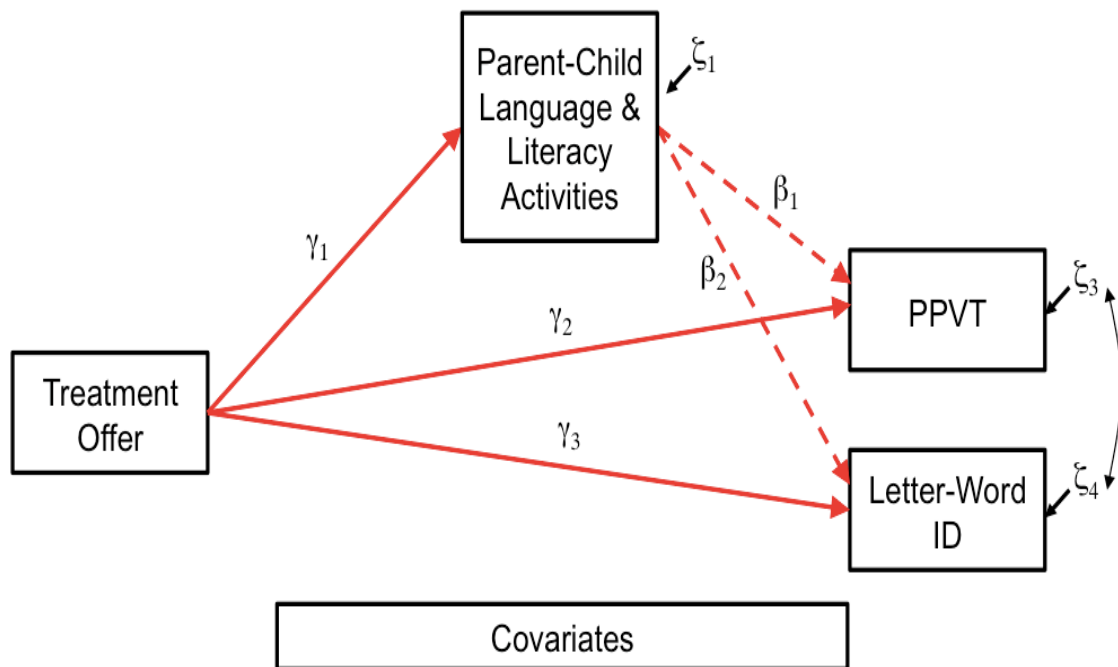


Table 1. Sample Means of Selected Characteristics, overall and by treatment and DLL status (n=3,578).

	Experimental Assignment			Language Status		
	Control (n=1,353)	Treat (n=2,225)	dif	Non-DLL (n=2,760)	DLL (n=1,025)	dif
Literacy Activities (S)	0.55	0.61	***	0.60	0.55	***
Literacy Activities (F)	0.52	0.55	***	0.57	0.45	***
Letter-Word scores (S)	309.18	314.85	***	315.13	306.03	***
Letter-Word scores (F)	299.98	301.23	ns	303.31	293.73	***
PPVT scores (S)	268.87	273.45	***	281.19	245.72	***
PPVT scores (F)	250.38	248.11	ns	257.86	224.55	***
Treatment offer	0	1	---	0.62	0.63	ns
Child age	4.03	4.03	ns	4.00	4.10	***
Child male	0.50	0.49	ns	0.50	0.50	ns
Child black	0.29	0.31	ns	0.40	0.01	***
Child Hispanic	0.37	0.37	ns	0.17	0.94	***
Child DLL	0.26	0.27	ns	0.00	1.00	---
Mother <HS	0.40	0.37	*	0.29	0.64	***
Mother HS	0.32	0.34	ns	0.37	0.22	***
Mother married	0.46	0.44	ns	0.37	0.66	***
Mother prev married	0.15	0.16	ns	0.17	0.11	***
Caregiver age	28.99	29.31	ns	28.80	30.25	***
Bio dad lives with child	0.50	0.50	ns	0.40	0.76	***
Mom recent immigrant	0.19	0.19	ns	0.04	0.58	***

Note: A statistically significant difference between the two groups noted as the following: ns=not significant, * $p<.05$, ** $p<.01$, *** $p<.001$.

Table 2. Definitions of Covariate Measures.

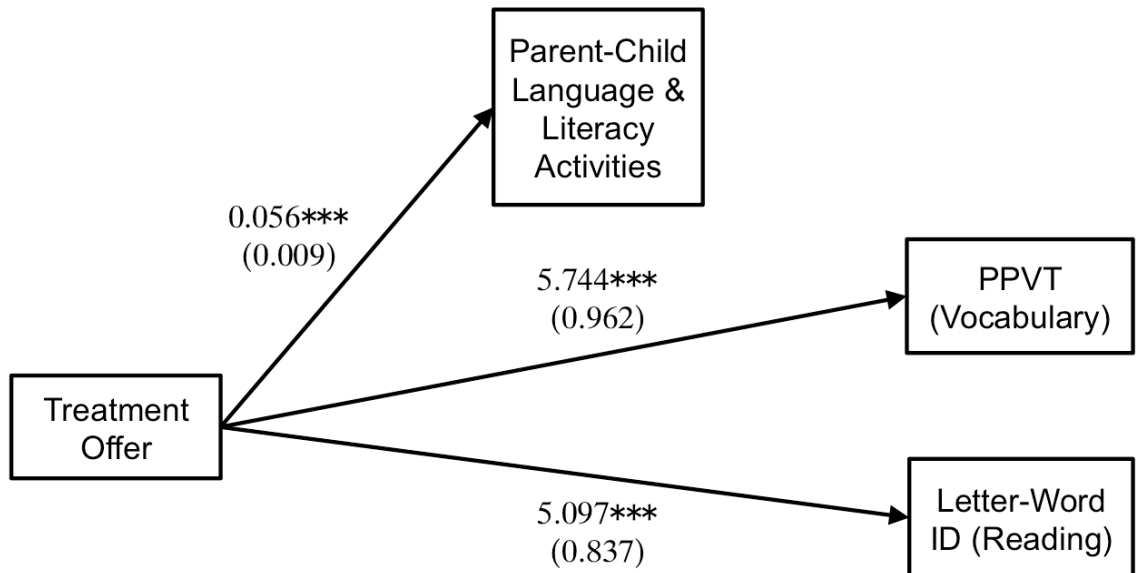
Variable Name	Definition
Child	
Characteristics:	
Female	Dichotomous variable indicating whether the target child is female (=1) or male (=0).
Race/ethnicity	Vector of dichotomous variables indicating target child's race/ethnicity (each coded 0/1 for White; Black; Latino).
Age	Continuous variable recording the age of the target child at baseline, in months.
DLL	Dichotomous variable indicating whether target child is a Dual-Language Learner (0=Non-DLL; 1=DLL).
Mother	
Characteristics:	
Age	Continuous variable indicating mother's age at baseline, in years.
Educational attainment	Vector of dichotomous variables indicating mother's highest level of educational attainment (each coded 0/1 for less than high school; high school; high school or more).
Marital status	Vector of dichotomous indicators (each coded 0/1 for not married; married; previously married).
Lives with child	Dichotomous variable indicating whether biological mother lives with child (0=no; 1=yes).
Recent immigrant	Dichotomous variable indicating biological mother's recent immigrant status (0=no; 1=yes). A mother is considered a recent immigrant if she was foreign-born and was in the U.S. for less than 10 years.
Pretest Scores:	
PPVT	Continuous variable indicating the target child's score on the <i>Peabody Picture Vocabulary Test</i> (PPVT) at baseline (range: 128-388).
Letter-Word Id	Continuous variable indicating the target child's W score on the <i>Woodcock-Johnson III Letter-Word Identification</i> at baseline (range: 264-396).
Study Design	
Controls:	
Center	Vector of dichotomous variables indicating the Head Start center to which the target child was randomly assigned to treatment or control.

Table 3. Estimated Bivariate Correlations among selected primary study variables.

	1	2	3	4
1. Treatment offer	-			
2. Literacy Activities (Spring)	0.12***	-		
3. Vocabulary (Spring)	0.06***	0.209***	-	
4. Reading (Spring)	0.10***	0.251***	0.486***	-

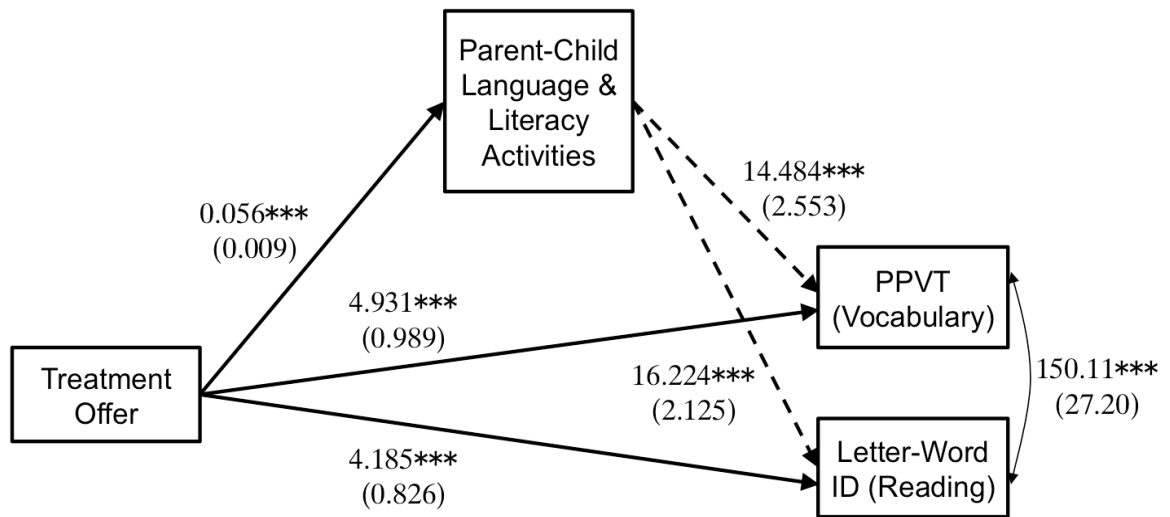
Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 2. RQ1: Estimated Causal Effects (with approximate p-values and standard errors in parentheses), of Head Start Treatment Offer on Parent-Child Activities and Child Vocabulary and Reading (obtained by MSEM).



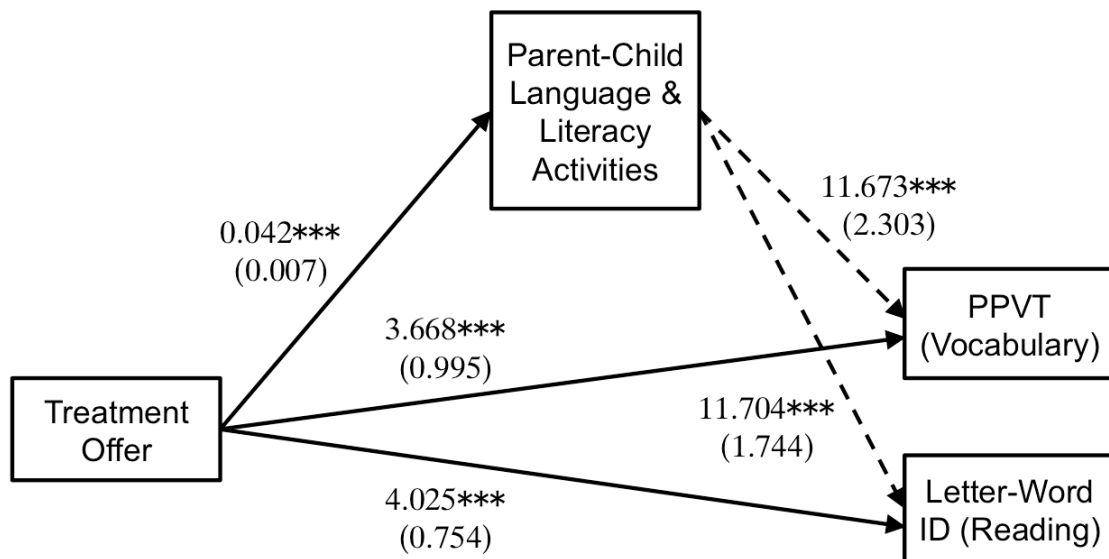
$\chi^2(27)=1514.72^{***}$; CFI=.97; TLI=.92; RMSEA=.04; SRMR=.05

Figure 3. RQ2: Estimated Indirect Effects (with approximate p-values and standard errors in parentheses) of Treatment Offer on Child Vocabulary and Reading via Parent-Child Activities (obtained by MSEM).



- Test of the mediational effect on PPVT ($b=0.813$, $p=.000$).
- Test of the mediational effect on LWID ($b=0.911$, $p=.000$).
- $\chi^2(27)=1514.72^{***}$; CFI=.97; TLI=.92; RMSEA=.04; SRMR=.05

Figure 4. RQ2: Indirect Effects (with approximate p-values and standard errors in parentheses) of Treatment Offer on Child Vocabulary and Reading via Parent-Child Activities (obtained by ACME).



- Causal mediation effect on Vocabulary ($b=0.484$, [.262, .776], or 11.7%.
- Causal mediation effect on Letter-Word ($b=0.473$, [.273, .719]), or 10.5%.

Note: The 95% confidence intervals for the ACME are based on nonparametric bootstrap with 1000 resamples.

Figure 5. Mediation Effects on Vocabulary and Reading for DLL (N=1,025).

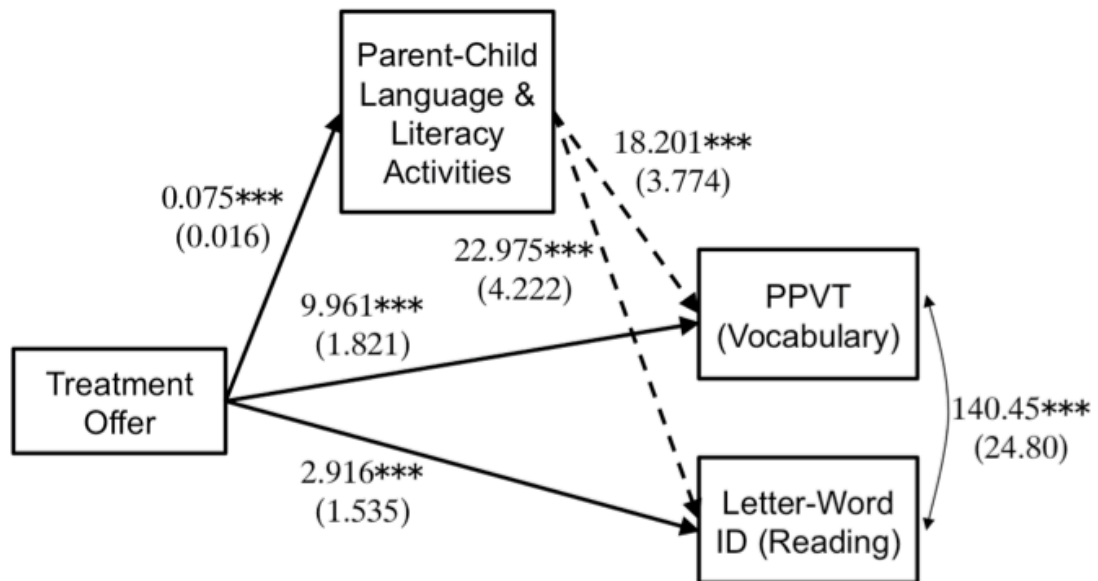


Figure 6. Mediation Effects on Vocabulary and Reading for Non-DLL

($N=2,760$).

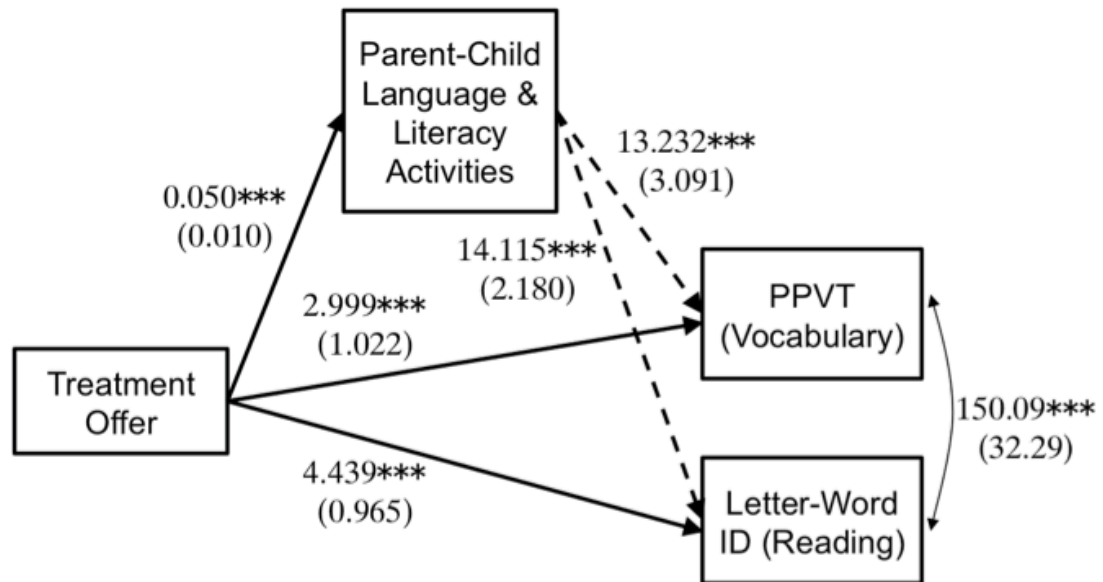
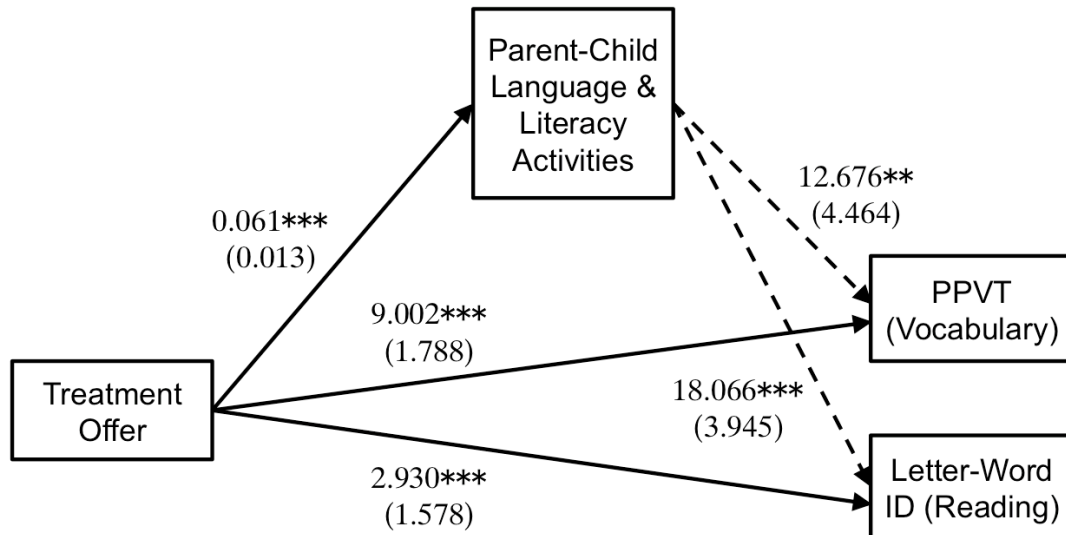


Figure 7. Causal Mediation Effects on Vocabulary and Reading for DLL

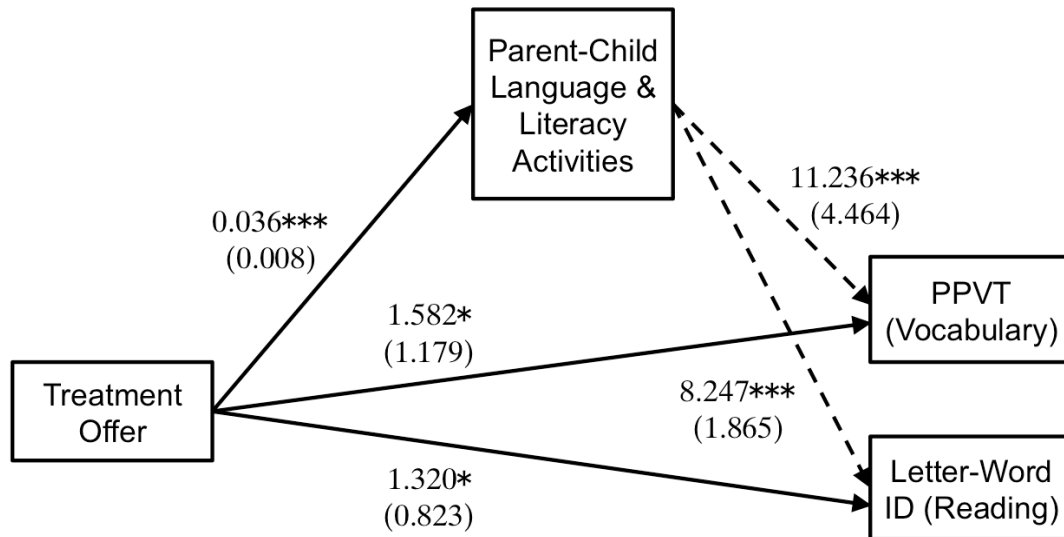
($N=1,025$).



- Causal mediation effect on Vocabulary ($b=0.774$, [.222, 1.462]), or 8%.
- Causal mediation effect on Letter-Word ($b=1.024$, [.466, 1.735]), or 26.2%.

Figure 8. Causal Mediation Effects on Vocabulary and Reading for Non-DLL

($N=2,760$).



- Causal mediation effect on Vocabulary ($b=0.384$, [.156, .681]), or 18.7%.
- Causal mediation effect on Letter-Word ($b=0.341$, [.147, .579]), or 7.5%.

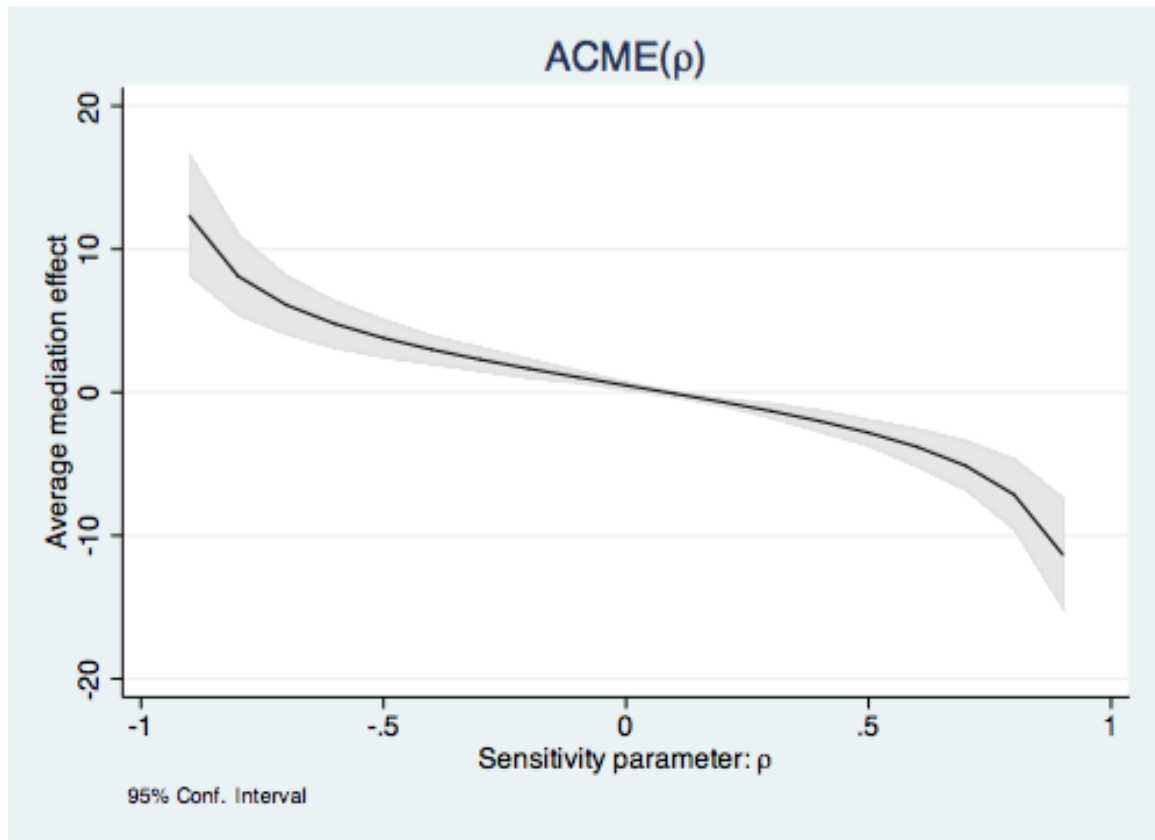
Table 4: Comparing Estimated Vocabulary Impact, by language status (Obtained by ACME).

Vocabulary	Effect	Language Status	
		DLL	Non-DLL
<i>ACME</i>	0.484	0.774	0.384
<i>Direct</i>	3.628	8.941	1.541
<i>Total</i>	4.112	9.714	1.925
<i>% Total Effect Mediated</i>	11.7%	8.00%	18.7%

Table 5: Comparing Reading Impacts for DLL vs. Non-DLL (Obtained by ACME).

Letter-Word	Total	DLL	Non-DLL
<i>ACME</i>	0.473	1.024	0.341
<i>Direct</i>	3.995	2.876	4.210
<i>Total</i>	4.468	3.899	4.550
<i>% Total Effect Mediated</i>	10.5%	26.2%	7.5%

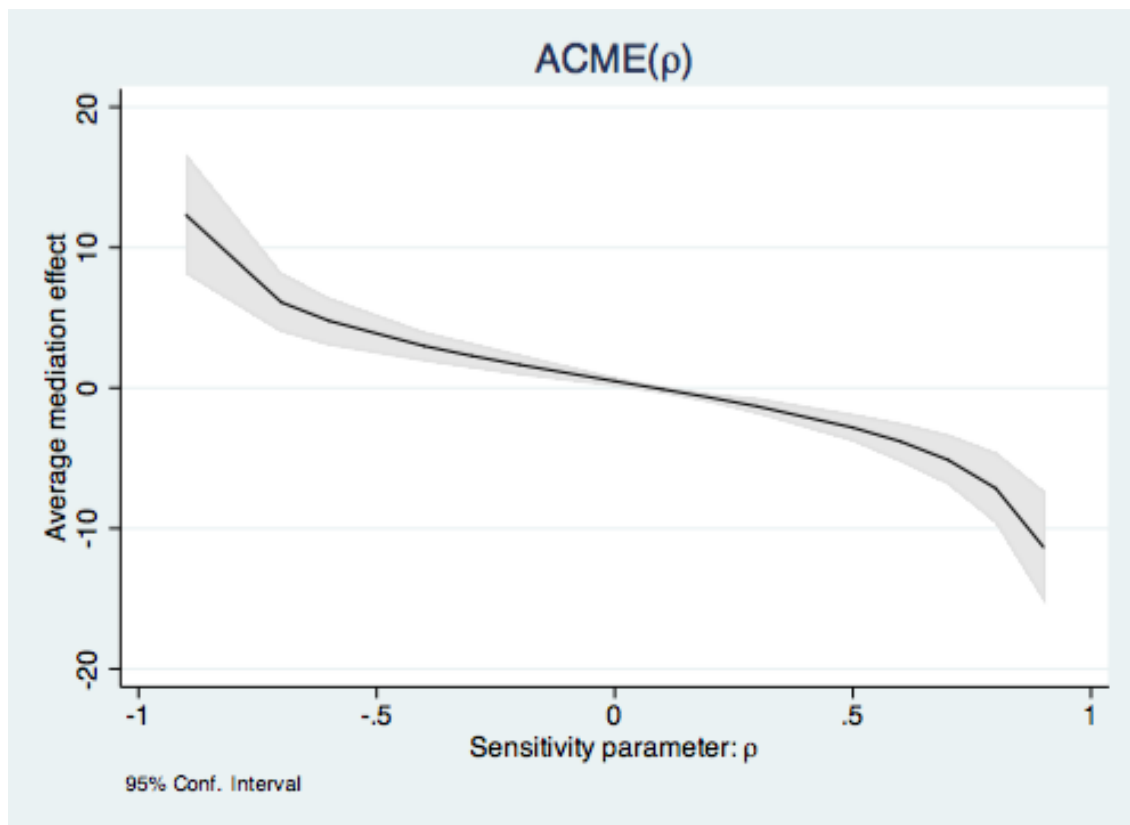
Figure 11. Sensitivity Analysis with Parent-Child Activities and Vocabulary



Note: In the above panel, the true ACME is plotted against the sensitivity parameter p , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of p .

Figure 12. Sensitivity Analysis with Parent-Child Activities and Vocabulary for

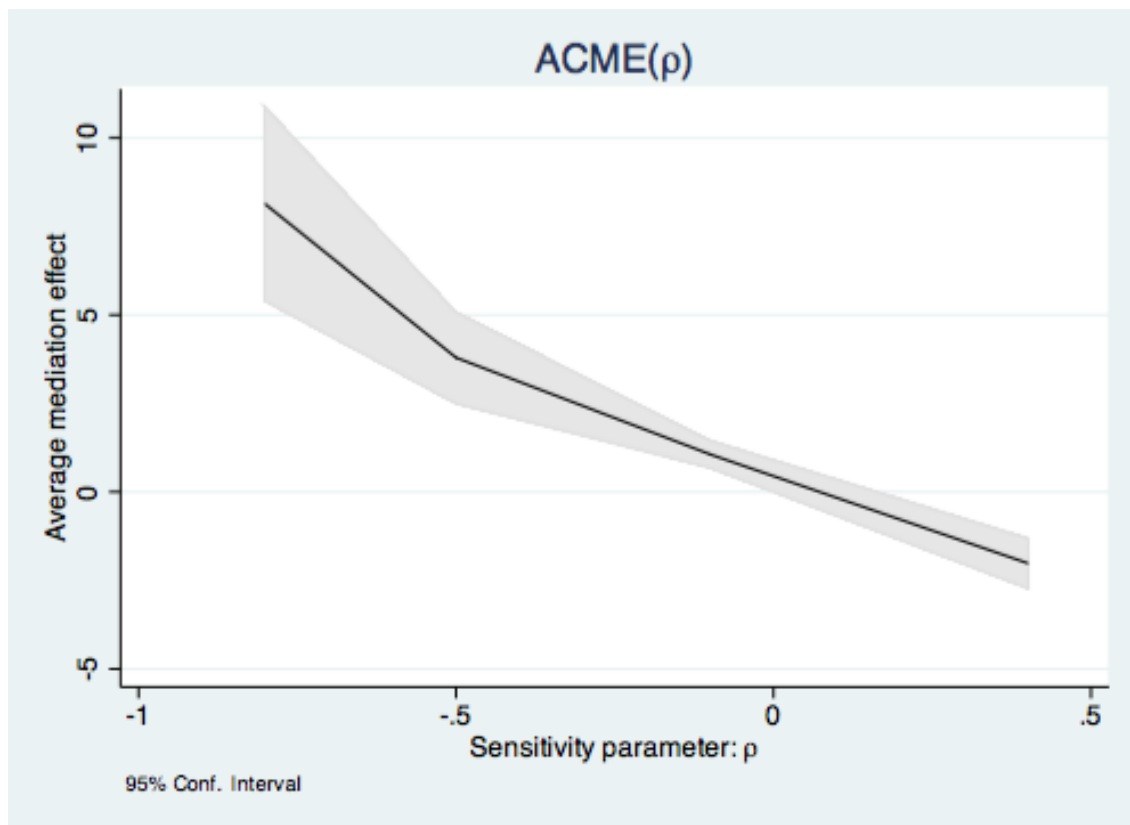
DLL



Note: In the above panel, the true ACME is plotted against the sensitivity parameter ρ , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of ρ .

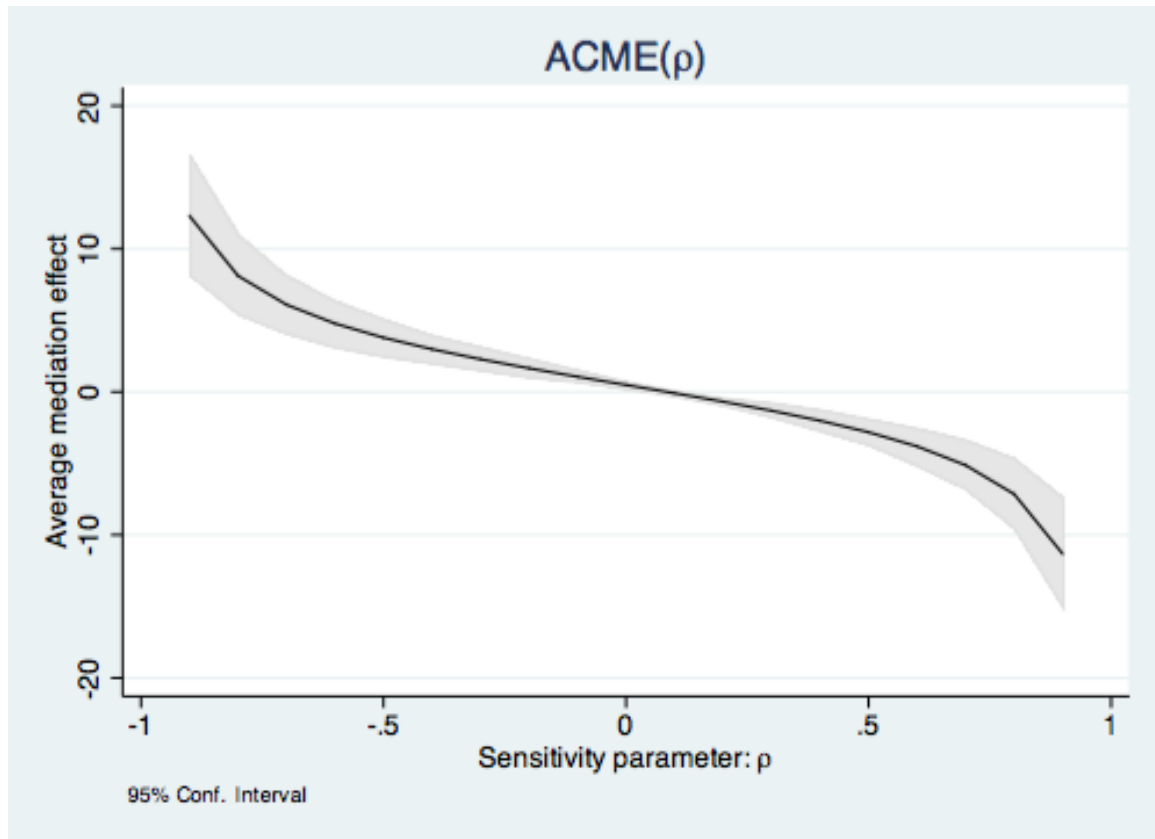
Figure 13. Sensitivity Analysis with Parent-Child Activities and Vocabulary for

Non-DLL



Note: In the above panel, the true ACME is plotted against the sensitivity parameter ρ , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of ρ .

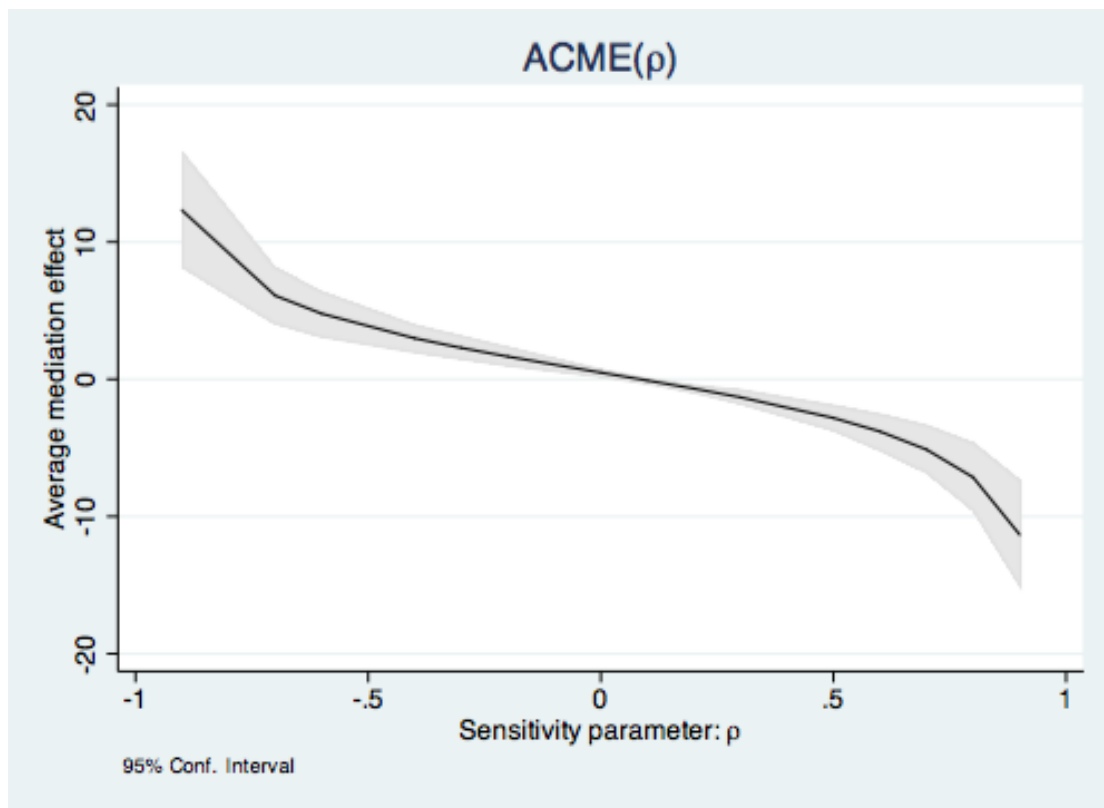
Figure 14. Sensitivity Analysis with Parent-Child Activities and Reading Skills



Note: In the above panel, the true ACME is plotted against the sensitivity parameter p , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of p .

Figure 15. Sensitivity Analysis with Parent-Child Activities and Reading Skills for

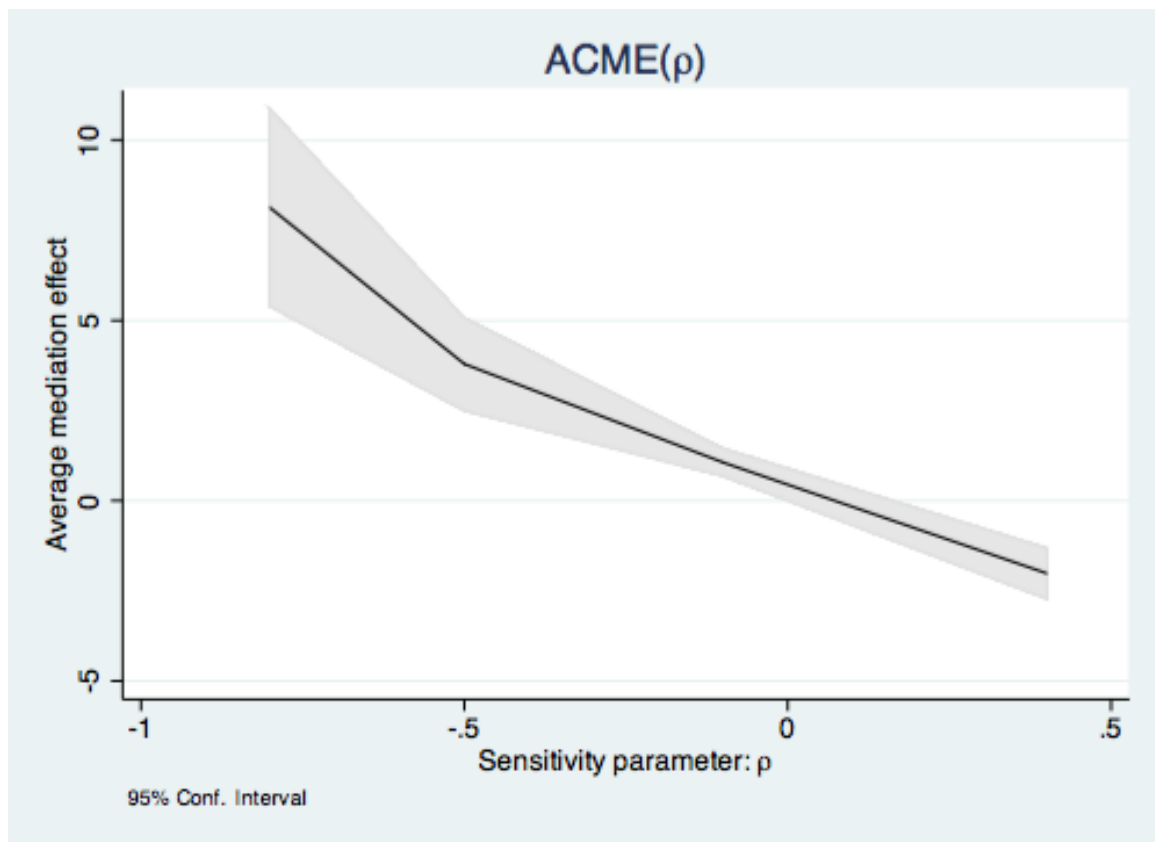
DLL



Note: In the above panel, the true ACME is plotted against the sensitivity parameter ρ , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of ρ .

Figure 16. Sensitivity Analysis with Parent-Child Activities and Reading Skills for

Non-DLL



Note: In the above panel, the true ACME is plotted against the sensitivity parameter ρ , which is the correlation between the error terms in the mediator and outcome regression models. The shaded areas in gray represent the 95% confidence interval for the mediation effects at each value of ρ .

Appendix A: Head Start Program Performance Standards (2008)**45 CFR 1304.21 Education and early childhood development.****(2) Parents must be:**

(i) Invited to become integrally involved in the development of the program's curriculum and approach to child development and education;

(ii) Provided opportunities to increase their child observation skills and to share assessments with staff that will help plan the learning experiences; and

(iii) Encouraged to participate in staff-parent conferences and home visits to discuss their child's development and education (see 45 CFR 1304.40(e)(4) and 45 CFR 1304.40(i)(2)).

45 CFR 1304.40 Family partnerships**(d) Parent involvement—general:**

(1) In addition to involving parents in program policy-making and operations (see 45 CFR 1304.50), grantee and delegate agencies must provide parent involvement and education activities that are responsive to the ongoing and expressed needs of the parents, both as individuals and as members of a group. Other community agencies should be encouraged to assist in the planning and implementation of such programs.

(2) Early Head Start and Head Start settings must be open to parents during all program hours. Parents must be welcomed as visitors and encouraged to observe children as often as possible and to participate with children in group activities. The

participation of parents in any program activity must be voluntary, and must not be required as a condition of the child's enrollment.

(3) Grantee and delegate agencies must provide parents with opportunities to participate in the program as employees or volunteers (see 45 CFR 1304.52(b)(3) for additional requirements about hiring parents).

(e) Parent involvement in child development and education.

(1) Grantee and delegate agencies must provide opportunities to include parents in the development of the program's curriculum and approach to child development and education (see 45 CFR 1304.3(a)(5) for a definition of curriculum).

(2) Grantees and delegate agencies operating home-based program options must build upon the principles of adult learning to assist, encourage, and support parents as they foster the growth and development of their children.

(3) Grantee and delegate agencies must provide opportunities for parents to enhance their parenting skills, knowledge, and understanding of the educational and developmental needs and activities of their children and to share concerns about their children with program staff (see 45 CFR 1304.21 for additional requirements related to parent involvement).

(4) Grantee and delegate agencies must provide, either directly or through referrals to other local agencies, opportunities for children and families to participate in family literacy services by:

(i) Increasing family access to materials, services, and activities essential to family literacy development; and

(ii) Assisting parents as adult learners to recognize and address their own literacy goals.

(5) In addition to the two home visits, teachers in center-based programs must conduct staff-parent conferences, as needed, but no less than two per program year, to enhance the knowledge and understanding of both staff and parents of the educational and developmental progress and activities of children in the program (see 45 CFR 1304.21(a)(2)(iii) and 45 CFR 1304.40(i) for additional requirements about staff-parent conferences and home visits).

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